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## Universal Milling Machine.

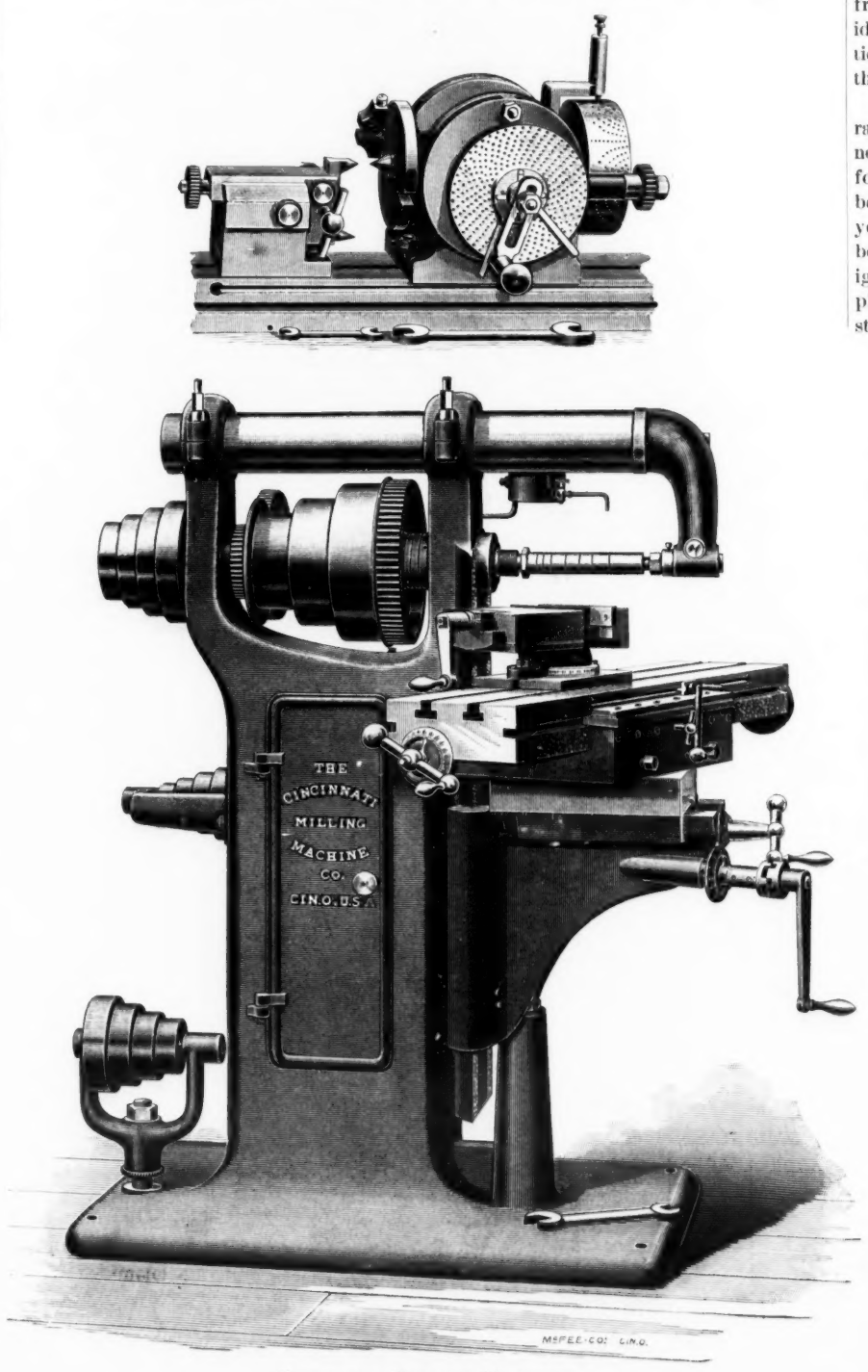
On this page we give an illustration of a milling machine, recently brought out by The Cincinnati Milling Machine Co., of Cinciunati, Ohio.

Besides embodying several new improvements, it is a larger and heavier machine than any heretofore built by this concern. The dividing and spiral head shown by a separate cut is entirely new. The swiveling block which carries the spindle can be revolved through a complete revolution, and has a T slot turned in it, so that it can be firmly clamped at any angle on either side of the vertical, or, in other words, the head can be turned forward or back, and clamped at any desired inclination either way.

This feature has several advantages which will be apparent to milling machine men and tool makers, amongst others being the fact that a given angular cutter will cut teeth in either a right or left-hand cutter, according to the way in which the head is turned, and in cutting such work as small bevel gears, which for any reason must project some distance from the head, things can be so arranged as to commence the cut at the back, thereby much reducing the liability of the cutter catching and gouging into the work. Cuts of this kind can only be taken by reversing the motion of the machine and feed, in the absence of a head which will swing over to either side as this does.

This head also has a double index, one of which is attached directly to the index spindle, while the other is at the side, and works by a worm and wheel. For rapid indexing on such work as taps, reamers, nuts, etc., and for gears with less than forty teeth, the former is used, the worm being disengaged from the wheel. This, of course, effects a saving in time, and some mistakes made in counting. As the worm-wheel has forty teeth in it, and divisions up to that number can be made with the plain index, more than one turn of the worm is never required. The spindle can be firmly locked during the cutting, thus relieving the worm or index of all strain from that cause. Change gears are furnished for cutting spirals. The spindle index plate is 8″ diameter, and the head will swing work 12″ diameter. The back center is elevated or lowered by means of a rack and pinion, and has a clamping device. The center bar has a large center at one end, and a small one at the other for the lighter work.

All the motions of the knee and platen are graduated by micrometers, and there is a quick-return motion to the platen. The overhanging arm can easily be pushed back out of the way, and as easily replaced in position at any time. The arrangement of feed pulleys is a new one, the pulley, supported in a yoke at the base, being adjustable to give the required tension to the belts, and admitting of their being endless, while the arrangement and number of steps is such that twelve different feeds are obtained for each spindle speed, the slowest being sufficiently fine for stem cutters. The platen is extra heavy, is 10¼″ wide, 47″ long, and has an automatic feed of 25″ at any angle to 45° It has practically square gibs which are adjustable, and can be firmly locked. Angular bearings of the knee on the column are 1⅞″ wide. Overhanging arm is 4½″ diameter. Cone pulley is 12″ diameter, driven by 3″ belt. Feed belt 1½″ wide.




UNIVERSAL MILLING MACHINE.

Some of those who are always searching for some wonderful solution in which to harden steel tools, might try some of those in use during the sixteenth century. One of these, which it was believed in those times would make steel very hard, was to "take snayles and boil them with rain-water taken in the two first months of harvest." Another was, "take the root of blue lilies, infuse it in wine, and quench the steel in it."

A sailing vessel recently took from New York 1,320,000 gallons of refined petroleum, said to be the largest cargo of the kind ever taken in one vessel.

## To Apprentices.

BY S. BOLLAND.

The whole of our trade is not learned exclusively in the foundry, and fortunate indeed is the apprentice of to-day, in having for his guidance so many avenues of information, other than the daily routine of the shop in which he is serving his time. Innumerable opportunities present themselves to-day for the young man's advancement in his trade, which did not exist when some of us were boys. Such being the case, it is surely not too much to expect that superior skill should be developed at this day, when compared with times past. The business of writing on the subject of moulding, has, until lately, been monopolized by theorists, whose efforts have in the main, proved failures, so far as the object for which they wrote is concerned; entirely misleading the uninitiated, and of no practical service to the workman; for the simple reason that the author has not had the practical training requisite to understand intelligently what he was writing about.

It is not to be expected that a mere observer of our trade, one who collects his data from books, equally as vague as his own ideas, can understand from such an apprenticeship that which a lifetime's experience in the work itself fails very often to accomplish.

True, there were some few engineers of rare ability in their own sphere who, seeing the necessity for useful and instructive manuals for the use of moulders, wrote works far beyond the intelligence of most moulders, yea, absolutely unintelligable to great numbers, owing to the fact that the moulders were ignorant of the various branches of natural philosophy, and therefore could not understand them.

These books are only to be found in the employer's office, unused, and covered with dust. During the last few years a gradual change has been taking place. We now find many of our most intelligent moulders, who are not afraid of publishing their opinions upon subjects relating to the trade they follow.

It used to be said that our best workmen were the least able to impart their own knowledge to others, but I am proud to say that many of our numbers have come to the front in foundry literature; conclusively refuting the above stigma.

My object in writing this is certainly not to excel as an author; that would be presumption on my part, inasmuch as my time has been spent in the foundry; but I am anxious to have a plain talk with young moulders, and, if possible, help them to understand their trade, as well as their responsibilities, better, in order to qualify themselves for preferment.

There has always been more or less repugnance on the part of parents to apprentice their boys to the trade of moulder, arising in a large measure from the fact that, to all appearance, it was not as clean and respectable as that of pattern maker or machinist; and moulders themselves have contributed in no small degree towards making it unpopular, lacking, as they have, a right appreciation of their calling; but, thanks to the influence of superior education, not only moulders, but also the rest of the iron trades, are beginning to realize that the trade of moulder is not only respectable, but that, in order to become an expert in the art, demands are made on the intelligence of the man, far greater than are required to master other branches of the metal industries.

The moral tone of our foundries has improved to a remarkable extent of late, and amongst our moulders are now to be found some of the brightest and best men of the day; men with whom no parent need be afraid or ashamed to trust their sons.

Reverting to the subject of cleanliness, I am persuaded that, if the same care was exercised to keep the foundry clean, and in order, as there is for the pattern and machine shop, we should hear less complaints on that head; and when we remember that the great Michael Angelo himself had to work amidst the chips and dust from the stone which he so marvelously chiseled, before he could accomplish the mighty works of art he has

given to the world, we need not be fastidious with regard to such minor matters.

"What age shall I apprentice my son?" is a question we often hear asked by the parent; if he is to be a moulder, let him not be older than fifteen years, as the nature of the profession demands that the apprenticeship shall be a long one; coming young to the work, he all the more readily adapts himself to the nature of his calling, and has ample time to go through the legitimate routine required to make a good mechanic.

Let me here observe that a great mistake is only too frequently made by the parents, when their boy commences work, and the boy himself readily falls into the snare, which is to imagine that there is no further need of school and study. Avoid this common error, young man, and realize, if you can, that now is the time to apply such knowledge as you already possess, and that you need to be making constant additions to your knowledge, and preparing the mind for the increased demands which will be made on you, as you march, as it were, step by step to the end of your apprenticeship. The fact that such results ensue from a certain course of action is not the whole solution of the problems which daily present themselves in the foundry; therefore let the intelligent young man, who has chosen to be a moulder, continue his education, by pursuing a course of study at home, or better, at one of the schools of technology, in such branches of natural philosophy as are likely to be of use to him whilst he is learning his trade.

By so doing, a real, and intelligent knowledge of the business will be acquired, as he goes along, enabling him to do that which hundreds of so-called moulders are unable to do, viz., to give a reason for every step he takes in the execution of his work.

Another desideratum is to cultivate the acquaintance of such of his shopmates as are upright and sober, and in all things, both in and out of the shop, let his deportment be such as will command the respect of his superiors; by so doing he will not only gain their good will and help, but will also be laying a foundation for the future, which will enhance his prospects more than he thinks for.

Of course the young man must not flatter himself that he is going to master all the intricacies of his trade without meeting many difficulties, and perhaps failures; but if after due effort on his own part, he should still fail to see his way clear, let him make known his troubles to the foreman, or some of the most skillful and sensible men, who will at once assist him to overcome his task, and take great pleasure in doing it.

Lastly, he must select for his companions, only such as will assist him to rise, being ever ready to reciprocate their efforts in his behalf; maintain a strict integrity and determine to manfully do his share in keeping up a high intellectual and moral standard in his profession.

## Practical Drawing.

By J. G. A. Meyer.

EIGHTY-SEVENTH PAPER.

*Problem* 100.

627. *Intersections of pyramid with prism.*

Let Figs. 509*a* and 509 represent respectively the vertical and horizontal projections of a prism and pyramid, the latter being passed through the former; it is required to find the lines in which the lateral faces of pyramid intersect the lateral faces of the prism.

The only difference in the conditions given in this problem and those given in Problem 97, is that in the latter problem, two of the lateral faces of the pyramid lie in planes which are perpendicular to vertical plane of projection, whereas, in the problem before us two of the lateral faces of the pyramid lie in planes perpendicular to the horizontal plane of projection.

Under the given conditions the line $h_2 f_2$ in Fig. 509 is the horizontal projection of lateral face ($b\ c\ b_3\ c_3$, $b_2\ c_2$) of the prism in points which are presented in Fig. 509 by the point $m_2$. Therefore through the point $k_2$ draw a vertical line cutting the lines $h\ f$ and

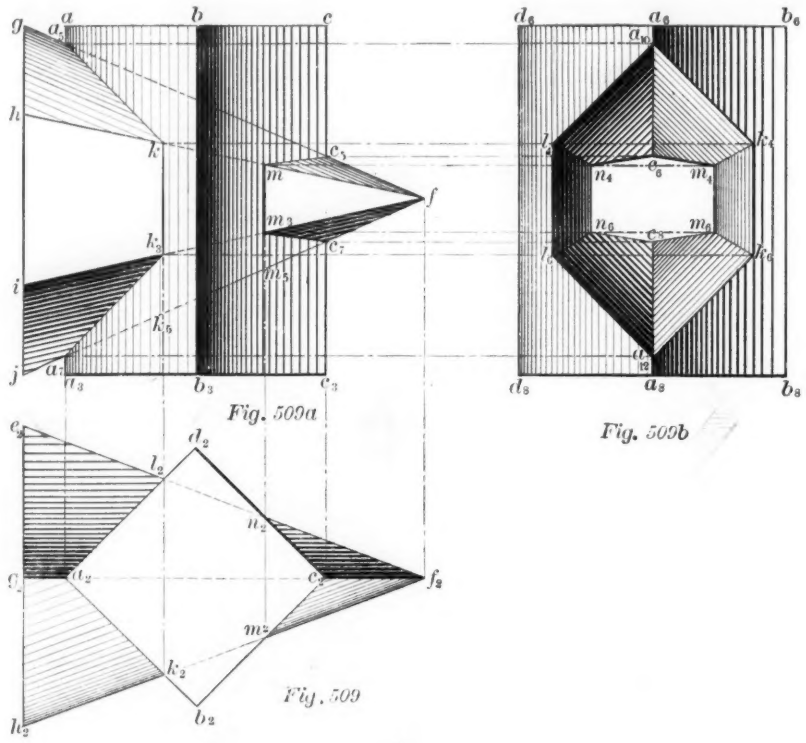


Fig. 509a



Fig. 509b



Fig. 509

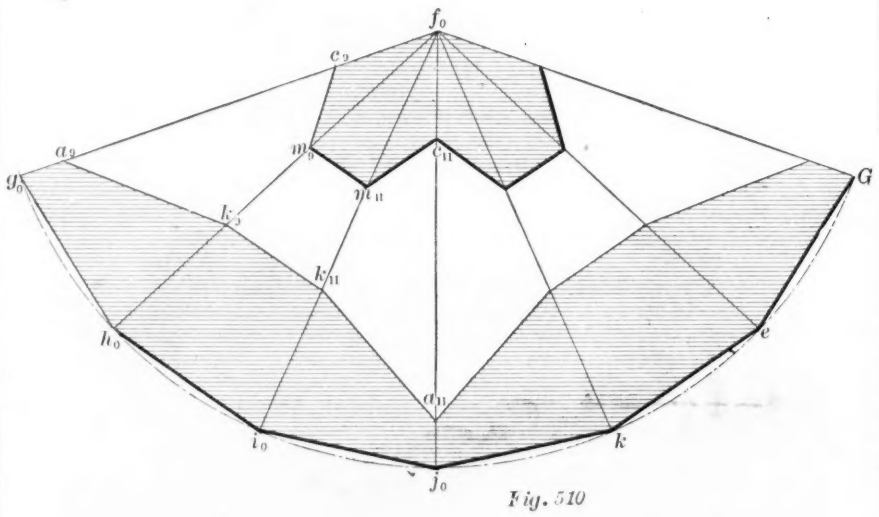


Fig. 510

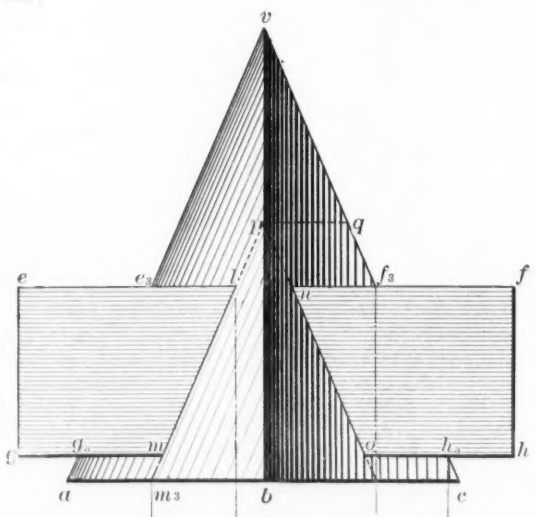


Fig. 511a

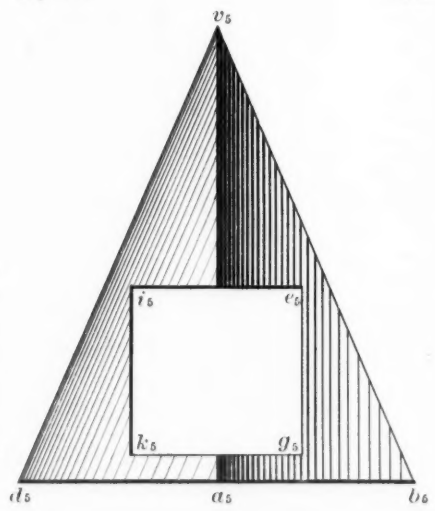


Fig. 511b

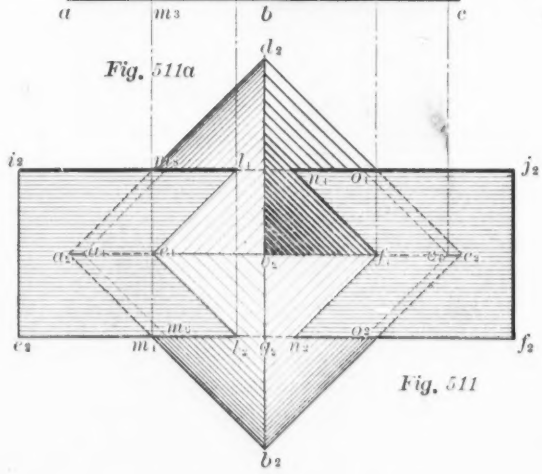


Fig. 511

will the intersection of the faces $h\ i\ f$ and $b\ c\ b_3\ c_3$.

The edge $g\ f$ of the pyramid (Fig 509*a*) cuts the edges $a\ a_3$ and $c\ c_3$ of the prism in the points $a_5$ and $c_5$; and $j\ f$ cuts the same edges of the prism in the points $a_7$ and $c_7$. Join $a_5$ and $k$, $k_3$, $a_7$ by straight lines; these lines and the line $k\ k_3$ are the lines in which three lateral faces of the pyramid cut the face $a\ b\ a_3\ b_3$ of the prism, and are some of those lines which were to be found. The lines in which the remaining three lateral faces intersect the face of the prism, which is hidden by the face $a\ b\ a_3\ b_3$, coincide with the lines just found. Join the points $c_5$, $m$ and $m_3$, $c_7$ by straight lines; these lines and the line $m\ m_3$ are the intersections of the three lateral faces of the pyramid—which are exposed to view in Fig. 509*a*—with the lateral face $b\ c\ b_3\ c_3$ of the prism, and are the remainder of the lines which were to be found. The lines in which the other three faces of the pyramid cut the face of the prism hidden by $b\ c\ b_3\ c_3$ coincide with the lines just found.

628. Fig. 509*b* represents another vertical projection of the prism, showing the opening made by passing the pyramid through it. The manner of finding in this figure the projection of the opening is similar to that of finding the opening in any one of the prisms previously shown. All that need to be said here is that the distance between the lines $l_4\ l_6$ and $k_4\ k_6$ must be equal to $l_2\ k_2$ in Fig. 509; and the distance between the lines $n_4\ n_6$ and $m_4\ m_6$ must be equal to $n_2\ m_2$. The vertical distances at which the points $l_4$ and $l_6$, $a_{10}$ and $a_{12}$, etc., should be placed are plainly indicated by the construction lines.

*Directions.*—In the space marked Problem 100, draw the vertical and horizontal projections of a prism and pyramid as shown in Figs. 509*a*, 509. Height of prism, 9 inches; base, 5 inches square; altitude of the right pyramid, 10 inches; hexagonal base, 8 inches across sides; the vertex of the pyramid is to project two inches beyond the edge $c\ c_3$. From the lower base of prism to the axis of pyramid, four inches. Find the intersections of the surface of pyramid and prism. Also in the same space—marked Problem 100—draw an elevation of the prism as shown in Fig. 509*b* Use 3-inch scale.

*Problem* 101.

629. *To find the development of the convex or lateral surface of the pyramid shown in Fig.* 509*a. Also, to indicate on this development those portions of this surface which lie outside of the prism.*

This development is shown in Fig. 510. The lines $f_0\ g_0$, $f_0\ h_0$, $f_0\ i_0$, etc., are each equal to $f\ g$ or $f\ j$ in Fig. 509*a*; and the lines $g_0\ h_0$, $h_0\ i_0$, etc., each equal to $h\ i$.

Let us assume that the surface of the pyramid is opened along the edge ($g f$, $g_2\ f_2$). In Fig. 509*a* we see that the portions $g\ a_5$ and $c_5\ f$ of this edge lie outside of the prism, and since our projections indicate that this edge is parallel to the vertical plane of projection, we know that the line $g\ f$ shows the correct length of the edge, and consequently the $g\ a_5$ and $c_5\ f$ also show the correct length of the portions of edge exposed. Therefore in Fig. 510 make $f_0\ a_9$ equal to $f\ a_5$ (Fig. 509*a*); and $f_0\ c_9$ equal to $f\ c_5$. The next edge ($h\ f$, $h_2\ f_2$) is not parallel to either plane of projection, consequently the line $h\ f$ or $h_2 f_2$ does not show the correct length of this edge, and therefore $h\ k$, $m\ f$, in Fig. 509*a*, or $h_2\ k_2$, $m_2\ f_2$ (Fig. 509) do not show the correct lengths of the portions of this edge which lie outside of the prism. To find the correct lengths of these portions we must draw in Fig. 509*a* vertical lines through the points $k$ and $m$, cutting the line $f j$ in the points $k_5$ and $m_5$. Then $j\ k_5$ will represent the true length of the portion $h\ k$; and $f\ m_5$ will be the true length of the portion $f\ m$. Hence in Fig. 510 make $f_0\ k_9$ equal to $f\ k_5$ (Fig. 509*a*) and $f_0\ m_9$ equal to $f\ m_5$. Again, the portions $i\ k_3$ and $m_3 f$ of the edge ($f\ i$, $f_2\ h_2$)

are equal to $h\ k$, and $m\ f$; therefore in Fig. 510 make $f_0\ m_{11}$ equal to $f_0\ m_9$; and $f_0\ k_{11}$ equal to $f_0\ k_9$. Lastly, $j\ a_7$ and $c_7\ f$ (Fig. 509*a*) are equal to $g\ a_5$ and $c_5 f$; therefore in Fig. 510 make $f_0\ c_{11}$ equal to $f_0\ c_9$, and $f_0\ a_{11}$ equal to $f_0\ a_9$. Join the points $c_9$, $m_9$; $m_9$, $m_{11}$; $m_{11}$, $c_{11}$ by straight lines; also join the points $a_9$, $k_9$; $k_9$, $k_{11}$; $k_{11}$ and $a_{11}$ by straight lines, and thus complete the development on the left of $f_0\ j_0$. The development on the right of $f_0\ i_0$ is an exact duplicate of the one just found.

*Directions.*—In the space marked Problem 101, find the development of the lateral surface of the pyramid shown in Fig. 509. Use 3-inch scale.

*Problem* 102.

630. *Intersection of pyramid with prism.*

Let Figs. 511*a* and 511 be the vertical and horizontal projections of a pyramid and prism, the latter being passed through the former. It is required to find the lines in which the faces of the prism intersect the faces of the pyramid.

Through the point $m_4$ (Fig. 511) in which the line $e_2\ f_2$ cuts the line $a_2\ b_2$, draw a vertical line cutting $a\ b$ (Fig. 511*a*) in the point $m_3$. Through the point $m_3$ draw a line $m_3\ p$ parallel to the line $a\ v$, cutting the line $g\ h$ in the point $m$, and also cutting the line $e\ f$ in the point $l$. The line $m\ l$—a portion of the line $m_3\ p$—will be the intersection of the lateral face $e\ f\ g\ h$ of the prism with the lateral face $v\ a\ b$ of the pyramid.

The upper face $e\ f$ of the prism (Fig. 511*a*) cuts the lateral face $v\ a\ b$ of the pyramid in a line $e_3\ l$; and the lower face $g\ h$ of the prism cuts the face $v\ a\ b$ of the pyramid in the line $g_3\ m$. The intersections of the prism with the face $v\ b\ c$ of the pyramid are found in a manner precisely similar to the foregoing, and in this problem the lines of intersections will be so situated as to make the projections of the pyramid symmetrical.

To find the horizontal projections of the lines of intersection, as shown in Fig. 511, we proceed as follows:

Through the point $l$ (Fig. 511*a*) draw a vertical line cutting $e_3\ f_3$ (Fig. 511) in the point $l_2$; also through the point $m$ draw a vertical line (not shown here) cutting $e_2\ f_2$ in the point $m_6$. The line $m_6\ l_2$ (a portion of $e_2 f_2$) will be the horizontal projection of $m\ l$; or, in other words, the lines $m\ l$ and $m_6\ l_2$ will be the projections of the line in which the face ($e\ f\ g\ h$, $e_2\ f_2$) of the prism intersects the lateral face ($v\ a\ b$, $v_2\ a_2\ b_2$) of the pyramid.

Through the points $l_2$ and $m_6$ draw lines parallel to $a_2\ b_2$, cutting the line $a_2\ e_2$ in the points $e_4$ and $a_4$; and through these points draw lines parallel to $a_2\ d_2$, terminating in the line $i_2\ j_2$. The line $l_2\ e_4$ is the horizontal projection of the line in which the upper face ($e\ f$, $e_2\ f_2\ i_2\ j_2$) of the prism intersects the face $v_2\ a_2\ b_2$ of the pyramid; and the line $m_6\ a_4$ is the horizontal projection of the line in which the lower face ($g\ h$, $e_2 f_2\ i_2\ j_2$) cuts the same face of the pyramid; and, lastly, the lines $e_4\ l_4$, $a_4\ m_8$ are the projections of the lines in which the upper and lower faces of the prism cuts the face $v_2\ a_2\ d_2$ of the pyramid.

The intersection $n_2\ f_4$, $o_2\ c_4$ are found in a manner similar to the foregoing. Or we may find the same intersection in another way. For instance, to find the line $n_2 f_4$, instead of drawing a vertical line through the point $n$ (Fig. 511*a*) and cutting the line $e_2 f_2$ in the point $n_2$, and then drawing through this point the line $n_2\ f_4$ parallel to $b_2\ c_2$, we may draw a vertical line through the point $f_2$ (Fig. 511*a*) cutting the line $a_2\ c_2$ in the point $f_4$, and then through $f_4$ draw a line parallel to $b_2\ c_2$, and thus obtain the line $f_4\ n_2$.

631. Fig. 511*b* is another vertical projection of the pyramid, showing an end view of the opening in it made by passing the prism through it. If no shade lines had been used, then the appearance of the projection of the opening would have been exactly like that of an end view of the prism, and when this figure is given in connection with the other two (and no shade lines used) we should naturally suppose that the square $e_5\ g_5\ k_5\ i_5$ does represent an end view of the prism. But the position of the shade lines shows that the square in Fig. 511*b* represents an opening. If, on the other hand, we want to convey the idea that the square represents the end of the prism, then the lines $k_5\ g_5$ and $g_5\ e_5$ must be the shade lines instead of $k_5\ i_5$ and $i_5\ e_5$.

*Directions.*—In space marked Problem 102 draw the vertical and horizontal projections of a pyramid and prism, as shown in Figs. 511*a* and 511. Altitude of right pyramid, 10 inches; base, 6 inches square; length of prism, 10½ inches; 3½ inches square; distance from base of pyramid to the lower face of prism, ¾ inch. Find the intersections. Use 3-inch scale.

*Problem* 103.

632. *To find the development of the lateral or convex surface of the pyramid shown in Figs.* 511*a and* 511.

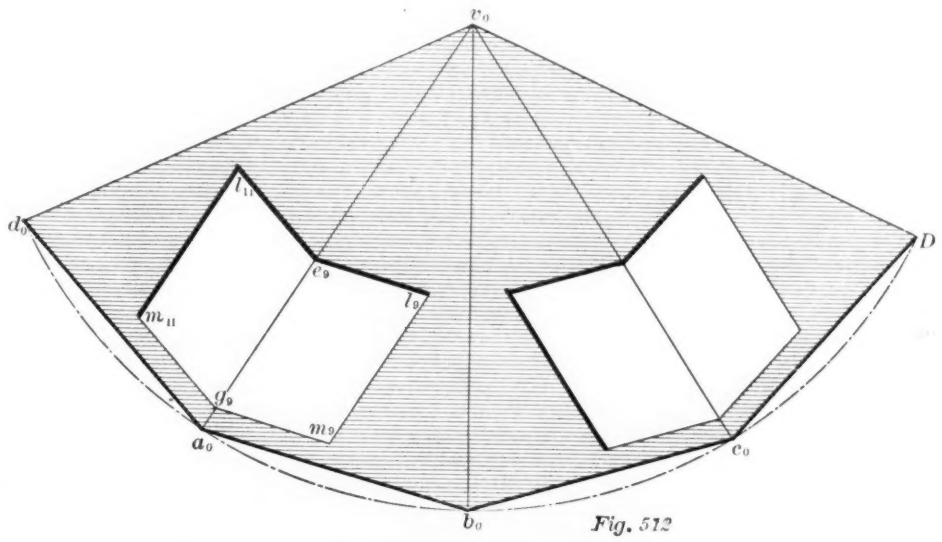


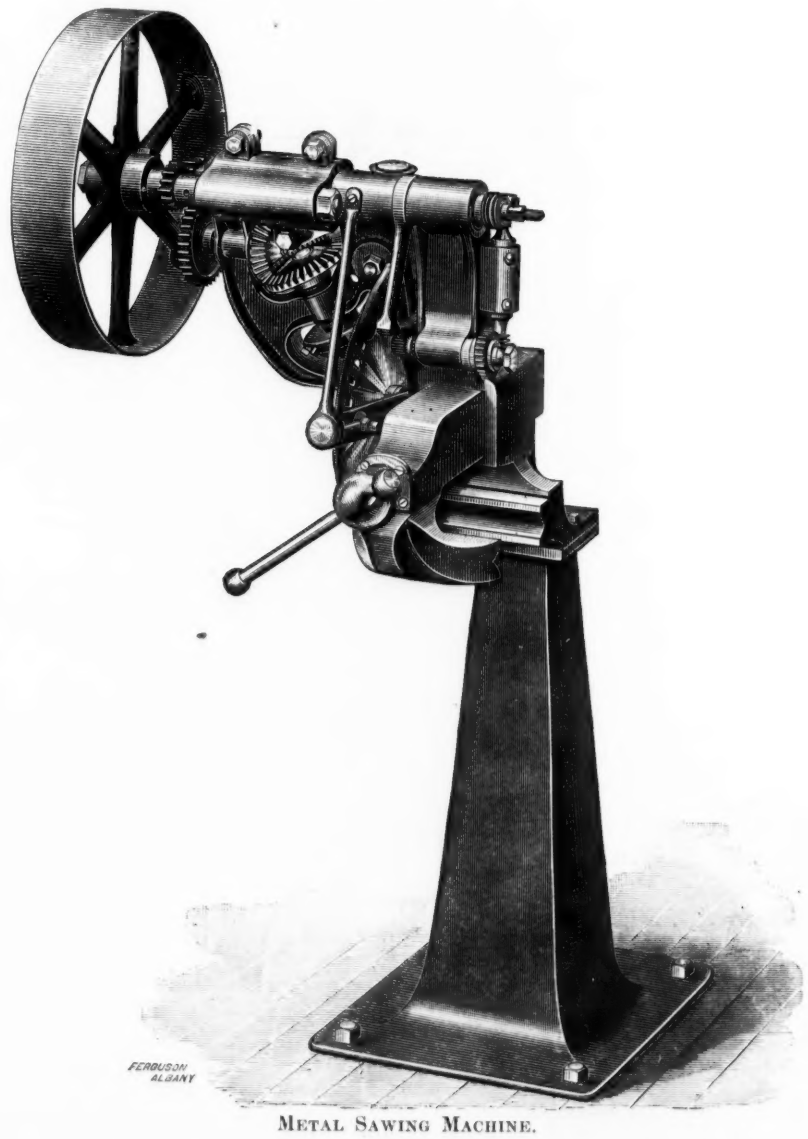

*Fig. 512*

Fig. 512 represents this development. The lines $v_0\ d_0$, $v_0\ a_0$, $v_0\ b_0$, etc., must be equal to the line $v\ a$ (Fig. 511*a*); and the lines $d_0\ a_0$, $a_0\ b_0$, etc., must be equal to $a_2\ b_2$ (Fig. 511); in fact, this development—leaving the openings out of consideration—is found as explained in Article 581 (Problem 86).

Now to find the openings in the development, we proceed as follows: Assume that the lateral surface of pyramid is opened along the edge which is represented in Fig. 511 by the line $v_2\ d_2$.

Fig. 512. On the line $v_0\ a_0$, lay off two points $e_9$ and $g_9$, making $v_0\ e_9$ equal to $v\ e_3$ in Fig. 511*a*, and $v_0\ g_9$ equal to $v\ g_3$. Through the points $e_9$ and $g_9$ draw the lines $l_{11}\ e_9$, and $m_{11}\ g_9$ parallel to $d_0\ a_0$. Make $l_{11}\ e_9$ equal to $l_2\ e_4$ in Fig. 511, and through $l_{11}$ draw a line parallel to $v_0\ a_0$.

Again, through the points $e_9$ and $g_9$ draw lines parallel to $a_0\ b_0$, and make $e_9\ l_9$ equal to $e_4\ l_2$, and through $l_9$ draw a line parallel to $v_0\ a_0$, and thus complete the development on the left of $v_0\ b_0$; the other half of the development is an exact duplicate of the one just found.




METAL SAWING MACHINE.

## The Higley Metal Sawing Machine.

A small, portable machine, for use on railroads in cutting off rails, and driven by hand, has been in use on many roads for some time, and from it has been developed the machine which forms the subject of our illustration, and which is designed for cutting up iron or steel of any shape into lengths. It is intended for general machine shop use, where it may be used for cutting up such stock as is usually cut off in the lathe or the cutting-off machine, up to 5½″ diameter, or for any square or irregular shaped bars of corresponding size; or it may be used in boiler shops for cutting off tubes, or in architectural iron-works for sawing up angle irons and beams of any section.

The machine consists essentially of a square pyramidal base, above which is an inserted vise having a strong steel screw, and jaws provided with V grooves, which square up and hold securely any shaped piece. Above the vise is a frame, in the top of which are the bearings for the main shaft, which is driven by the pulley at the left. Arranged to swing from a center which coincides with the center of this shaft, is the frame which carries the cutting saw and its driving mechanism, the feed being obtained by the swinging of this frame, effected by means of a toothed segment and pinion, driven from the main shaft by the worm gearing shown at the right. The saw—which in this machine is 12″ in diameter, and about ⅛″ thick—instead of being driven from the center, or by means of the arbor upon which it is mounted, is driven by a peculiar bevel gear made of hardened steel, the teeth of which engage with holes near the periphery of the saw, and having straight radial sides. The saw runs through guides which are placed on each side in the rear of and in front of this gear, as well as at other points, and is thus driven with a very powerful and steady motion, without danger of "buckling." The speed of the saw is about that of a milling cutter, or 45 feet per minute.

The outer face of the worm-wheel on the horizontal feed shaft has a piece of hard wood let into it, upon which the hexagonal friction nut is seated. When this nut is loosened the frame and saw can be swung back or adjusted to position by hand, and, when cutting hard steel, or stock liable to have hard spots in it, this screw is left sufficiently loose to slip and avoid injuring the saw, while on softer stock it may be made tight, and a heavy feed obtained.

Of course, the principal cause of the satisfactory working of the machine is the method of driving the saw close to the periphery, which admits of the use of a light saw, soft enough to be filed. Three saws accompany each machine, and they are found to work satisfactorily when cutting at the rate of about one square inch of solid section per minute, taking an average of 50 to 100 cuts before requiring filing.

The machine is also made without the base, and with a hand-crank on each end of the shaft, instead of the pulley, making a portable hand machine of it, for use on outside jobs of architectural or bridge work.

It is also made in various other sizes and styles, adapted to different classes of work, the machine shown being designated by the builders as the "C" machine. It is being introduced by J. J. McCabe, 121 Liberty street, New York city, where a machine may be seen in operation.

## It is Still Going the Rounds.

Two years ago this present month we went to considerable pains to find the mixtures for brass castings used at one of the large locomotive works in this country, and published the same for the benefit of our readers. This article has been doing good duty ever since, in helping to fill the columns of our contemporaries with useful matter, but it never has yet been credited to the proper source. The last time it made its appearance was in the September number of *The Practical Mechanic*, where it was credited to "an English paper."

Sugar trust stock recently took a very decided tumble, greatly to the discomfiture of the holders. It may have been a reflex of the writing on the wall.

## Involute Teeth for Skew-Bevel Gears.

By George B. Grant.

In the case of spur gears for axes that are parallel, or in the case of bevel gears for intersecting axes, we can have an infinite number of different forms of theoretically correct teeth, among which the involute and the cycloidal are the best known.

But in the case of skew-bevel gears, for axes that are not in the same plane, although several forms of teeth have been proposed, Herrmann's involute tooth is probably the only one that is demonstrably correct. This does not refer to spiral gears, having point contact, which may be of any odontoidal form.

The purpose of this article is not to go into the subject of the skew-bevel gear in general, but simply to describe the involute tooth in detail. This has not yet been done in the English language, for the brief statements in Klein's translation of Herrmann's Weisbach cannot be called a description.

The foundation of the theory of the skew-bevel tooth may be said to be Herrmann's universal law, which, in brief, requires the tooth surfaces to be formed by a straight line generatrix point, which is so moved that it is always parallel to the instantaneous axis.

If the law is correct—and there seems to be no way of attacking it or reason for doubting it—the "spiraloidal" tooth of Olivier, the cycloidal tooth of Willis, and the form of tooth proposed by MacCord, must all be incorrect. See the American Machinist for Sept. 5, 1889, concerning the inaccuracy of the cycloidal tooth generally described by writers on mechanism. A simple modification of the instrument there described would probably show that the Olivier tooth, like the Willis tooth, has a point of intersection upon the line of action, and that the Herrmann tooth has there a point of tangency.

But the involute tooth obeys the law, and, although it may not be the only possible tooth, it is the only one yet proposed, or likely to be, although it is not safe to make positive statements concerning the theory of the hyperboloidal gear tooth.

We have given the two axes $O\,A_1$ and $O\,A_2$ of Fig. 1, making the shaft angle $A_1\,O\,A_2$, and situated at a certain distance from each other at the common normal or gorge line $O$, and we wish to connect them by skew-bevel gears having a certain velocity ratio.

We have first to locate the instantaneous axis, and determine the gorge radii and the skew angles.

Lay off the distances $O\,A_1$ and $O\,A_2$ in the proportion of the given velocity ratio, draw $A_1\,C$ and $A_2\,C$ parallel to the axes, and through their intersection draw the instantaneous axis $O\,C$.

Draw any line $a_1\,j$ at right angles with the instantaneous axis, lay off the gorge distance $a_1\,a_2$ at any convenient angle, draw $j\,a_2$ and draw $e\,c$ parallel to it. Then $a_1\,c$ is the gorge radius for the axis $O\,A_1$, and $a_2\,c$ that for the axis $O\,A_2$.

Then, as in Fig. 2, draw the axes $O\,A_1$ and $O\,A_2$, and the instantaneous axis $O\,C$, as found by Fig. 1. Draw the intersecting plane $P$ at right angles with $O\,C$.

On this intersecting plane, Fig. 3, $c$ is the instantaneous axis, $c\,a_1$ the larger and $c\,a_2$ the smaller gorge radius. The axis $O\,A_1$ intersects the plane at $b$, and $O\,A_2$ at $b_2$. The three points of intersection $b_1$, $c$ and $b_2$, must be in the same straight line called the "line of centers."

In Fig. 2, $B_1$ is the gorge cylinder for the axis $O\,A_1$, and $B_2$ that for the axis $O\,A_2$, touching each other at the intersection of the instantaneous axis and the gorge line. The instantaneous axis is tangent to both cylinders. The ellipses of Fig. 3 are the intersections of the gorge cylinders by the plane $P$.

Now imagine a plane $K$ called the "plane of action," tangent to both the cylinders. It will contain the instantaneous axis, and its intersection with the plane $P$ will be the line of action $k\,c\,k$, tangent to both ellipses.

Imagine this plane of action to move in the direction $N\,M$, at right angles with the instantaneous axis, and with a velocity represented by $N\,M$. It will roll on both cylinders and move them with circumferential velocities determined by drawing the line $V_1\,V_2$, intersecting the lines $N\,V_1$ and $N\,V_2$ drawn at right angles to the axes.

As the plane moves, a chosen line $G$ in it, parallel to the instantaneous axis, called the "generatrix," will trace upon the cylinders the spirals $S_1$ and $S_2$, and in the space surrounding the cylinders, and moving with them, will sweep up two involute surfaces, which will always be in tangent contact with each other at the generatrix.

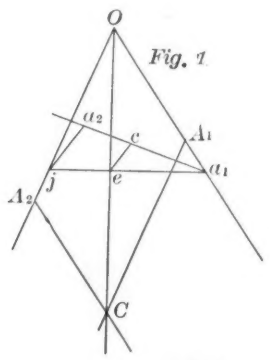


Fig. 1

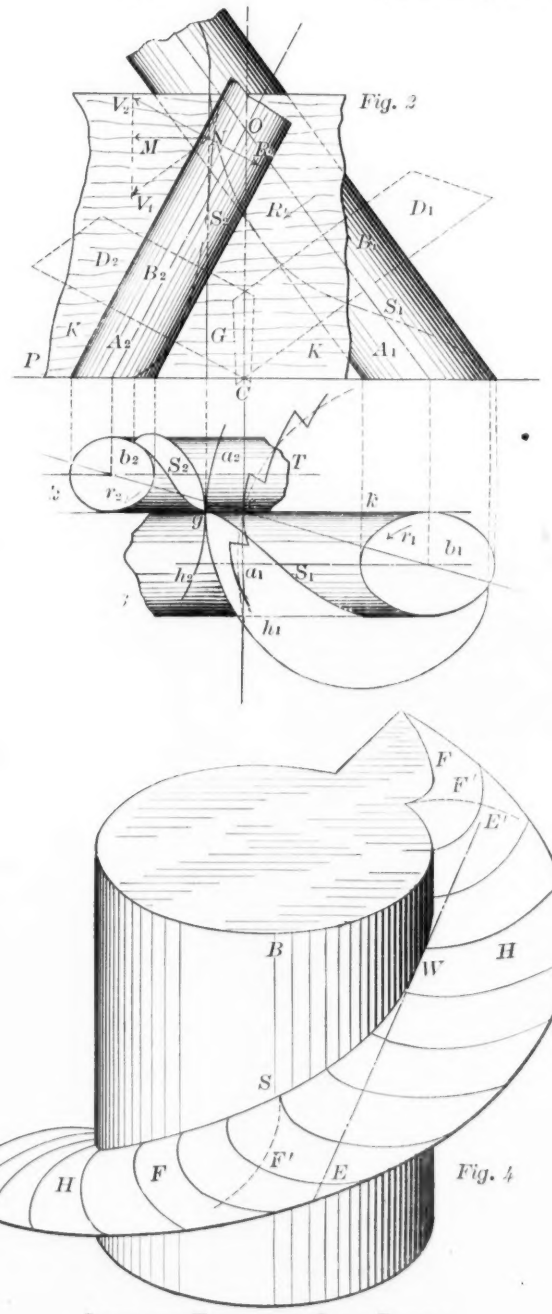


Fig. 2

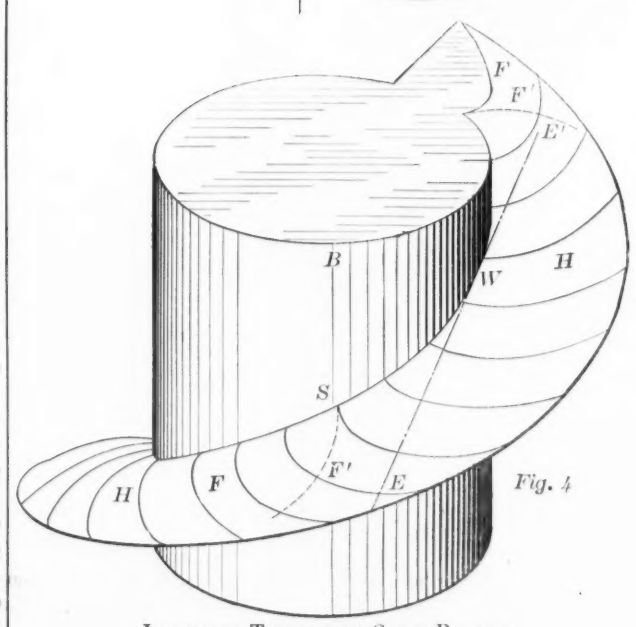


Fig. 4

Involute Teeth for Skew-Bevels.

The intersections of these tooth surfaces by the plane $P$ will be the curves $h_1$ and $h_2$, resembling involutes from the ellipses, which are always tangent to each other at the line of action, and at right angles to that line.

The intersection of the surface by a plane normal to its axis will be an involute of the circle cut from its gorge cylinder by the same plane.

Fig. 4 shows one of these surfaces in relief. It is an endless screw surface $H$ winding about the gorge cylinder $B$, springing from the cylinder at the spiral $S$, and being cut off as desired.

It may be considered as formed in two ways—by moving a straight line $E$ so as to be always tangent so the spiral, or by moving an involute $F$ with its foot always on the spiral.

It is a double surface, being formed of two branches meeting in a cusp at the spiral. The straight line $E\,E'$ is an element of the first branch from $E$ to $W$, but beyond, from $W$ to $E'$, is an element of the second branch, of which the involute $F'$ is a section.

In Fig. 2, $D_1$ and $D_2$ are the pitch cones of two gears, being frustra of pitch hyperboloids limited by the same points on the instantaneous axis.

Fig. 5 (page 2) is a projection of a full gear upon a plane through the gorge circle, and is easily drawn by means of the facts that the section of the tooth is an involute of the gorge circle, and that the surface is composed of straight line elements that are tangent to the gorge cylinder. To insure continuous contact it is sufficient that the element $Z$ at the point of each tooth crosses the working curve $I$ of the next tooth, as at $J$.

The tooth cannot have both fronts and backs, as is the case with spur and bevel teeth, and therefore the skew-bevel gear can run in but one direction, and that direction is fixed by the position of the axes. The gear $D_1$ of Fig. 2 will drive the gear $D_2$ with the shafts turning in the directions shown by the arrows $R_1$ and $R_2$, and if $D_2$ drives, the shafts must turn in the other direction. If the driving gear $D_1$ is uppermost, the shafts must turn in the contrary directions. If there are two pairs of gears, one on each side of the gorge line, the shafts may be turned in either direction.

The construction of the back of the gear is a matter of no importance, as it does no work.

The peculiar shape of this tooth is most clearly shown by Fig. 6, which is a perspective projection of Fig. 5. One tooth is continued to the gorge circle to show its construction. This shows the tooth joined to the gorge cylinder $B$ at the spiral $S$. The root element is tangent to the cylinder at a point on the spiral; the pitch element $E$ is tangent to it at the gorge circle; and the point element would be tangent to it at a point beyond.

The figure shows the tooth as of material size at the gorge circle, but in practice the part of it that would go inside the gorge cylinder of the mating gear must be cut away, for the reason that the tooth is subject to the same troublesome interference with the second branch that limits the addendum of the common spur or bevel involute tooth.

This tooth does not appear to have the valuable property of adjustability possessed by the common spur or bevel involute tooth, as the shape of the tooth is entirely fixed by the size of the gorge cylinder and the skew angle. Any change in the shaft angle would change the skew angle, and any change in the gorge distance would change the gorge radius. Therefore any gear is serviceable only for the gorge radius and the skew angle for which it is formed.

We can have a species of interchangeability of skew-bevel gears. If, in Figs. 2 and 3, we draw any number of axes intersecting the gorge line at right angles, and intersecting the plane $P$ at some point of the line of centers, they will form a surface called a "hyperbolic paraboloid" or "locus of axes." Any two gears, on axes that are elements of this locus of axes, will run with each other, either externally or internally, and have the same plane of action, line of action, and line of centers.

If we increase the distance of the gorge line $O$, Fig. 2, from the plane $P$, we decrease the shaft angle. If the distance is made infinite, the shafts will be parallel and the common spur gear system will result, the gorge cylinders becoming the base cylinders.

If, however, we bring the shafts parallel by decreasing the shaft angle directly, we do not produce the common spur system, for in that case the gorge cylinders become the pitch cylinders, and we have only a particular case, and an impracticable one, of the common system.

The common involute system for bevel gears is not produced by reducing the gorge distance to zero; for in that case the gorge cylinders are reduced to lines, and there appears to be no analogy whatever between the two systems.

Therefore the skew-bevel involute tooth cannot be said to be the general case of the tooth of which the common spur and bevel involute teeth are particular cases, as we could of the cycloidal tooth system if it was correct. Still, the method of its generation, as well as its properties and form, entitle it to the name "involute."

The practical construction of the tooth is a simple matter if its theoretical construction is thoroughly understood. The gorge cylinder being made and the spiral drawn upon it, an involute of the cylinder is attached. With a rule that is always held so as to touch the involute and the spiral at the same time, the tooth surface can be accurately fitted, and in that way a pattern for casting the gear can be made. The rough tooth can be accurately planed to shape on a common planer, by the use of special attachments that will hold the blank with its axis parallel to the planer platen and inclined to the line of the motion at the skew angle of the gear. The blank is revolved and the tool fed at each cut by amounts in proportion to the speeds of the gorge cylinder and the plane of action, as found above.

The tooth is theoretically perfect, but is practically very objectionable, and should be avoided whenever possible. When the axes are far apart they can be connected by two pairs of common bevel gears and an intermediate shaft, and when the axes are very close together a fair piece of work can be obtained by twisting a common tooth to the line of the instantaneous axis. In any case the sliding of the teeth on each other will soon wear them out of shape if they are required to convey a heavy power.

The greatest practical objection is the usually extreme obliquity of the action, which increases rapidly with the distance of the tooth from the gorge. Fig. 5 shows that the obliquity at the back of the gear is much greater than at the front. The gear must be placed very near the gorge to secure a reasonable obliquity, and when so placed its addendum must be small and teeth fine to avoid interference.

The angle of obliquity increases rapidly as the gorge distance decreases, and therefore this kind of tooth is very poorly adapted for the most usual case of skew-bevel gearing, that in which they are used simply to allow two shafts to just pass each other. This is well shown at $T$, Fig. 3.

In conclusion, it may be said of the skew-bevel gear that it is a difficult thing to study and understand, a troublesome thing to practically apply, an inefficient thing in operation, and, altogether, a very good thing to let alone. It is an excellent and interesting study, and has proved a fruitful source of learned mathematical controversy. It may well be monopolized by professors and their books.

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The catalogue of an English manufacturer shows triple expansion engines of 35 h. p.

## Experiments upon the Transmission of Power by Compressed Air in Paris.

Mr. Alexander B. W. Kennedy read a paper before the British Association on the above subject, from which we make extracts below :

The subject of transmission of power to a distance is one of such immense importance in an industrial country like our own, that I am sure I need offer no apology for bringing this paper before Section G of the British Association. In a case such as that which I have to describe to you, where the distance to which the power is to be transmitted is great enough to be measured in miles, the possible methods of transmission are not very numerous. Steam, water, air, and electricity seem to be the only four agents practically available. All four have been used to a greater or less extent, and with more or less complete success. In our own country the distribution and use of high-pressure water has been carried out with the greatest engineering skill and with correspondingly great success by the Hydraulic Power Company in London, and also in Hull. Electric transmission (for traction at least) has been at work on a small scale for some time in various places, and is about to be tried on a much larger scale, under Mr. Greathead on the Southwark Subway. In America it has been very widely used for traction on tramways, and on the Continent it has also been used to a certain extent for power transmission for general purposes. Steam has been used on a large scale in New York, but as yet its success does not seem to be unquestionable. Compressed air has, of course, been used over and over again in rough and uneconomical fashion in connection with tunneling and boring work, but I think only two practical attempts have been made to utilize it economically and on a large scale for industrial purposes. Of these two, one has been made in Birmingham and the other in Paris. The Birmingham Compressed Air Power Company has established works on a very large scale, but various causes have unfortunately combined to cause delay in the commencement of its operations, which, indeed, are hardly yet fairly started. In Paris, however, the transmission of power by compressed air has been in operation on a somewhat large scale, and with very great mechanical success for a few years past. I have recently had occasion to spend some weeks in making experiments in connection with the Paris compressed air plant, and having been given the fullest permission to publish the results of my experiments, I have pleasure in taking this opportunity of bringing them before the members of the British Association. To avoid any misunderstanding I must premise that it is not my intention to institute any comparison between the different methods of power transmission which I have mentioned. Such a comparison, to be of any value, would require for itself a paper, at least as long as the one which I have to put before you, and is, therefore, in the nature of things impossible here. On this matter I wish to say only one thing, in view of a recent discussion on the Hydraulic Power Company's work in London, in which some comparisons were made between power transmission by air and by water. So far as I see, the two systems at present practically occupy different fields, and overlap but little. The work that each appears to do best is exactly that for which the other is least fitted. I see as little chance for air, just now, taking the place of water for lifts or cranes, as I do for water coming into common use in the driving of motors. I think it would be a pity if there were to be any impression that two systems were antagonistic, which, in point of fact, rather supplement each other. Having said this much, it will, I think, be my most useful and most interesting course to limit myself to a description of the plant and methods used in Paris, and to a statement of the actual results obtained there, as determined by my own experiments on the spot. The plant and methods are by no means absolutely perfect ; they are not only susceptible of, but are now receiving considerable improvements in detail in the extensions which are being carried out. In what I have to say, however, I shall confine myself entirely to results actually obtained with the present plant, as it was working when I tested it two months ago, not giving it credit for the result of any of the improvements which have not yet been introduced throughout into the system of working. I shall only, after having given this statement of facts, state briefly my views as to the probable practical value of improvements which may be, or are being, carried out.

The work now carried on by the Paris Compressed Air Company has developed from very small beginnings, at first slowly, lately very fast. It originated in a pneumatic clock system, which was started about 1870 with a small "central station" in the Rue St. Anne, in the center of Paris. This

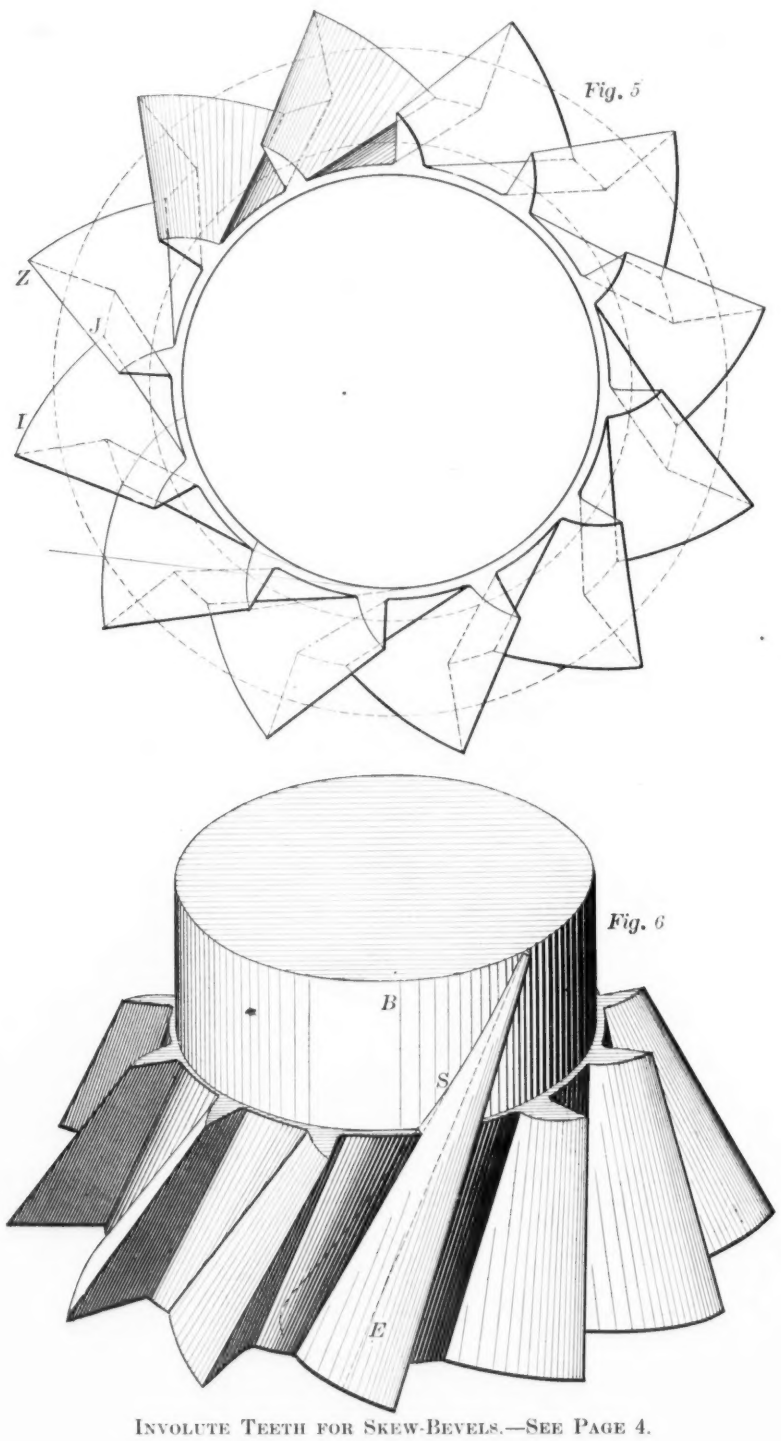



*Fig. 5*

*Fig. 6*

Involute Teeth for Skew-Bevels.—See Page 4.

business grew gradually until it became far too large to be carried on from such a position, and a few years since a central station, with much enlarged machinery, was established in the Rue St. Fargeau, which is in Belleville, about 4½ miles east of the Madeleine. There are now about 8,000 pneumatic clocks, public and private, in Paris, driven from St. Fargeau, and regulated by a standard clock in the Rue St. Anne; but as this part of the work, although it originally formed the basis of the whole system, is now a comparatively very small part of it, and is of an entirely special nature, I do not propose to say anything further about it here. Until about two years since a pair of single-cylinder horizontal engines by Farcot, and a beam engine by Casse, sufficed for the whole work, but by that time the demand for compressed air for working motors had so increased that extension had become imperative, and the present working plant of six compound condensing engines, each working two air compressors, with the necessary complement of boilers, was put down This plant, except the compressors, was supplied from England by Messrs. Davey, Paxman, & Co., of Colchester. The compressors for the English engines were made in Switzerland on the Blanchod system. The demand for power is at present so great that, at certain hours of the day, practically the whole plant, old and new, indicating considerably over 2,000 horse-power, is fully at work, and in consequence a duplicate main is being laid throughout, and new engines and compressors, half of them constructed by Davey, Paxman & Co., and half by John Cockerill & Co., of Seraing, are being pushed forward as rapidly as possible. After a description of the compressors, in which there is nothing novel, the author continues :

After compression, the air, now having an absolute pressure of six atmospheres and a temperature of 150° Fahr., is pushed into large boiler plate receivers, of which some are arranged to act as separators, and in these a large portion of the cooling water, which has been carried along mechanically by the air, is deposited and removed, before the air enters the mains. The principal main is 300 mm. (11.8 inches) in diameter and about three-eighth inch thick. It is of cast-iron, made in lengths perfectly plain at each end, and connected by a very simple external joint made air-tight by india-rubber packing rings. This joint leaves the pipe quite free endwise, and also allows all necessary sideway freedom, so that accidental distortion to a quite measurable extent is entirely without effect on the tightness of the joint. The mains are partly laid under roadways and footways as they would be in this country, and partly slung from the roof of the sewer subways. They are supplied at intervals with automatic float traps for carrying off the entrained water and the water of saturation, as they deposit.

On entering a building on its way to a motor, the air is first passed through a meter, exactly as gas would be. The quantity passing is, of course, too great to allow anything like an ordinary gas meter to be used; indeed, only inferential meters seem to have been at all successful. The meter actually in use in Paris is a small double cylindrical box. The air passes by a branch through to the bottom of the inner box, up through it, down outside it between the two boxes, and away through a branch at the bottom opposite the inlet branch. The whole measuring apparatus is a little four or six-armed fan, with aluminium or nickel vanes, placed near the bottom of the inner casing and communicating motion by a light vertical steel spindle to a clockwork register, like that of a gas meter, placed on the top. The quantity recorded is simply the number of revolutions made by the fan, or some proportional number, and this is turned into cubic meters by multiplication by an arbitrary constant, determined by direct experiment. As to the working of this meter, I shall have something to say later on; it is the only type used by the Paris company, and serves in a very large number of cases as basis of payment.

After passing the meter the air is carried through a reducing valve, by which the initial pressure in the motor is prevented from rising above a certain limit, which in practice appears to vary between 3½ and 5½ atmospheres absolute, according to the size of the motor in proportion to its work.

Between the reducing valve and the motor there is placed in all ordinary cases a small stove or heater. This heater is simply a double cylindrical box of cast-iron, having an air space between its outer and its inner walls. The air under pressure traverses this space, and is compelled, by suitably arranged baffle plates, to circulate through it in such a fashion so as to come into contact with its whole surface. A coke fire is lit in the interior of the stove, and the products of combustion are carried over the top of it, and made to pass downwards over its exterior surface, inside a sheet-iron casing, on their way to the chimney flue. The heater for the motor on which I experimented—which indicated 10 to 12 horse-power—was about 21 inches in diameter and 2 feet 9 inches high over all. The use of the heater, and the extent to which that use is advantageous and economical, are matters on which I shall touch later.

The motors themselves used in Paris are mainly of two types. Up to one horse-power or thereabouts, small rotary engines, of a form patented by M. Popp, are used; into the details of these it is not necessary to enter here. They start very readily, are easily governed, are provided with capital automatic lubricators worked by compressed air, run at a very high speed, and are altogether very convenient. They use the air with little or no expansion, without previous heating, and have, of course, no pretense to economy in use of air.

The larger sized motors, up to double-cylinder engines 12 inches by 14 inches, which is the largest size used, are simply ordinary Davey-Paxman steam engines, employed for air absolutely without any alteration or modification. These engines have, in most cases, automatic cut off gear controlled by the governor, and can, therefore, easily work with the largest economical ratio of expansion for the not very high available initial pressure. I believe that in every case heaters are provided for these engines, although in some instances, where both power and refrigeration are required, they are used sparingly or not at all, in order to take advantage of the cooling due to expansion.

Mr. Kennedy tested the efficiency of this means of transmission, and found that about 50 per cent. of the power of the main engine could be delivered as work. This, he thinks, could be exceeded by simple means, so that the efficiency would be 67 per cent.

### Captain William R. Jones.

In the death of William R. Jones, the country loses one of the most prominent men connected with its steel industries—a man whose knowledge of the manufacture of steel was of that practical character that makes it positive and certain. At the time of his death he was only 50 years old, and hence had the prospect of many years of usefulness before him. His death, which occurred Saturday, September 28, was the direct result of an accident at the Edgar Thompson Steel Works at Pittsburgh, of which works he was manager.

Captain Jones had very limited educational advantages, being apprenticed to the Crane Iron Co. at the early age of 10, and at the age of 14 he was receiving journeyman's wages as a machinist. Drifting about to various places, he was at Chattanooga, Tenn., at the breaking out of the war, from which place he went North and enlisted in the Union army, coming out at the close of the war with the rank of Captain.

He was with the Cambria Iron Company at Johnstown, Pa., for eight or nine years after the conclusion of the war, and in 1873 accepted a position with the Edgar Thompson Steel Company, of which company he was soon made general manager, receiving probably the largest salary ever paid a practical steel maker, beside a large sum in the way of royalties. It is said that from his income he gave to different charities, unostentatiously, more than ten thousand dollars a year.

The life of Captain Jones is an excellent example for young men to consider. Starting at the foot of the ladder, without the advantages of an education, he worked his way to the topmost round in his chosen vocation, at the same time securing the highest respect of the community in which he lived. Such men achieve success for themselves, and make the world better.

Lester J. Pease, a well-known business machinist, of Worcester, Mass., died in that city September 25th. Mr. Pease was born in Buffalo, N. Y., in 1843, and, with a limited education, worked his way up to a position of prominence in the manufacturing business of Worcester.

## LETTERS FROM PRACTICAL MEN.

### Test Bars in Foundry Practice.

*Editor American Machinist:*

The form of test bar shown in the annexed figure seems better than any I have seen illustrated. The pattern is made 1″ square by about 14″ long, with two Vs projecting as shown. These Vs are 12½″ from center to center, and it matters not how much the pattern is rapped in the sand, the Vs in the mould will remain 12½″ from center to center also; to determine whether the shrinkage is more or less than standard, it is only necessary to measure the castings from V to V with a foot-rule when cold. These same Vs serve as knife edges on the testing machine, and the "tit" on the opposite side entering a center of the screw makes the most simple arrangement to insure the pressures being applied correctly. It seems to simplify the whole business, and the bar is in no way weakened by the action of the screw.

J. E. S.

### Melting Iron in Small Quantities.

*Editor American Machinist:*

George B. Grant wants to know how to melt iron in small quantities.

The smallest and simplest cupola that I ever heard of is a ladle that will hold about 150 pounds of iron. Daub it about 1½ inches thick with loam or fire-clay; get a piece of pipe about two feet long, and one foot diameter, and daub it the same as ladle.

Dry both ladle and pipe thoroughly, and set the ladle with the carrying handle on so it will not tip over, then set the pipe top of ladle, leaving a hole to insert the blast pipe, with an opening 1¼ inch or 1½ inch.

For melting, coke is best in small sizes, but anthracite coal will answer. The iron should also be in small pieces, so it will melt easier.

With a rigging of this sort 75 or 80 pounds of iron can be melted in a short time, and with a moderate blast.

When the iron is melted push the pipe one side, skim the ladle, and make your little casting. I have done this frequently in Scotland, back in the years 1833 and 1834.

William H. Thompson.

Rock Island, Ill.

### Chimney Draught.

*Editor American Machinist:*

In your reply to your correspondent, W. H. J., you state that "draught in a chimney before the fires are started is caused by air in chimney having a higher temperature than the outer air."

I beg to say that my experience would lead me to take a different view, as I know it is quite possible for an upward draught to exist in a chimney whilst the internal air is at same, or even a colder temperature than the outer air, and I account for it by the velocity of air passing horizontally over top of the chimney tending to produce by induction a partial vacuum in the chimney, thereby causing an upward draught. G. H. E.

St. John, N. B., Canada.

### Air Consumption per Pound of Fuel.

*Editor American Machinist:*

It is so usually understood from frequent statements, especially derived from Professor Rankine, that with an ordinary chimney draught the amount of air passing through a furnace amounts to about 24 pounds per pound of coal consumed; this being about double the theoretical minimum. Of course it is a simple matter for a chemist to ascertain the composition of the gaseous products of a furnace. Gases are thus collected for analysis in bottles—often by means of a concertina bellows, and then analyzed.

Now this 24 pounds of air is found to be the amount used, because the furnace gas analysis shows that there are present 12 pounds of free air as well as the 13 pounds of mixed gases, resulting from the 12 pounds of air, which has been usefully employed in burning the one pound of fuel.

My faith in the talismanic 24 pounds of air has now commenced to give way, and I need hardly say that I have experienced a shock, not because I have based any calculations upon what now seems doubtful, but simply because of the failure of so respectable a standard engineering belief. Figures based on the smoke analysis, and temperature at the chimney base, will still be equally trustworthy as of old, nor do I doubt the accuracy of the chemist's analysis. My cause for doubt arises from the porosity of brick-work. We all know that bricks, when dry, will absorb large quantities of water; a full grown English brick will absorb—am I right here?—about a pint of water. Anyhow, it is somewhere about this, and proves a brick to be exceedingly porous. So porous a substance cannot fail to be very pervious to air or other gas. Just here I will not dwell on the property of gases known as diffusion, but will assume its existence as if a proved fact, and ask how is it possible to expose a brick wall of perfectly dried bricks to two mixtures of gases at different pressures, without the passage of the one mixture to another? A chimney draught may be equivalent to only a small difference of pressure, nevertheless we have to face this fact, that air at 15 pounds pressure per square inch is pressing on one side of a casing of brick within which is furnace gas at perhaps 14 pounds 15 ounces. In fact, the outer gas has an inward tendency of probably 1 ounce per square inch, with a draught of a 200 feet chimney.

In Lancashire boilers, with which I am most familiar, an ordinary size, as 84 inches diameter, set by itself will expose along its side walls alone nearly 300 square feet of porous brick-work, through which the outer atmosphere is tending to pour in—is pouring in, in fact, all day long.

By so doing it is reducing the whole flue temperature, and leading, also, to the belief that the coal is obliged to have more air than really it does have, and I believe this has had a bad effect in checking improvements, and therefore I point it out.

In conversation to-day with a manufacturer of fans, the subject came up, and I ventured to ask, had he found brick-work to be porous, and was not a little surprised to find that he had done so in a degree far more marked than I had anticipated. He said that they had sometimes been complained to, that these fans did not give the results they should in cupola work, and on investigation they had found that the blast pipe from fan to cupola was for part of its length a brick-work culvert, through which much air, and pressure, got away. He was very certain that brick-work was exceedingly permeable to air, and asked me what should be done with brick work. My advice given to steam boiler users has already been to give the bricks a thorough soaking with coal tar, the last coat to be made a little thicker by an admixture of pitch. This should stop all pores, and prevent air from being drawn in.

If by doing this the chimney is relieved of the duty of passing 30 or 40 per cent. more gases than it need do, it stands to reason, that the temperature within it must be much higher, and by so much the draught will be improved, and any improvement in the draught would, if properly utilized, as a reason for shortening the grate, be made to secure better combustion, and with still less air. The fire temperature would be higher, and the percentage of rejected heat lower, and evaporation would be greater per pound of fuel.

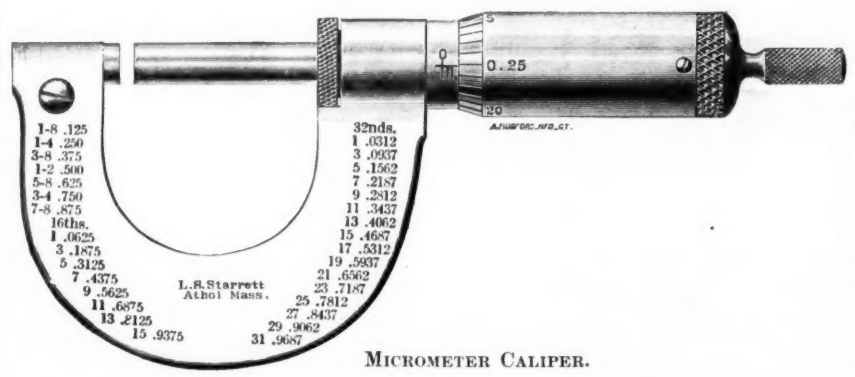
As bearing upon the subject, an experiment has been recently reported by Mr. Longridge, Manchester, wherein, being dissatisfied with his boiler results, a steam user allowed Mr. Longridge to make tests. First under ordinary conditions a pair of Lancashire boilers were shown to pass 20.7 pounds of air for each pound of coal. The damper next the chimney was kept open, and the fires worked with this good draught, and fairly thin. The air consumed was, as above stated, 20.7 pounds per pound of coal.

On the second test the chimney damper was kept much less open, and the fires from 9 to 10 inches thick, and the gas analysis showed that only 14.8 pounds of air was passed through per pound of fuel, and, as a proof of the correctness of the practice, the evaporation of water per pound of fuel was thereby increased from 9.9 to 10.91 equivalent evaporation from and at 212°, an increased efficiency of 11 per cent. on the total plant of boilers and feed heaters, the results showing that while of course the furnace temperature would be higher, the boiler heating surface was able to reduce the gases to 648° in place of, as formerly, to 700°, and the further reduction by the economizer was to 390° instead of to 450°, the smaller volume of gases passing over the heating surface being longer exposed to the cooling influence of the plates. This test by an engineer of Mr. Longridge's standing is very satisfactory, as proving the necessity of the thick fires, which I have frequently advocated in the American Machinist, and bears out the advisability of preventing air passing through the porous brick-work of boiler settings.

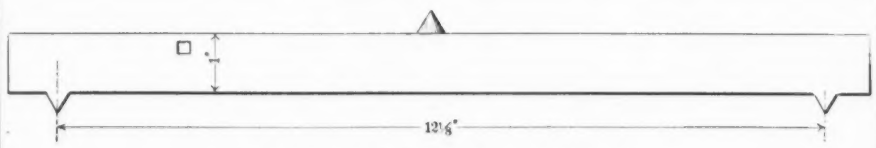
Mr. Longridge states that if the grates were now to be shortened, and the draught again put to the full power, the fuel being, perforce of shorter grates, obliged to be kept up to 10 inches thick on the grates, the same good results would follow. This would be so, if the leakage of air could be stopped, for it cannot be overlooked, that, with the better draught, there is the increased liability of air leakage. Where boilers are set in brick-work, air draws in at every chance opening, and in setting a boiler it ought not merely to rest on the front wall, brick to iron, but an elastic rope of asbestos should interpose, on which the boiler can slide as it expands and contracts, and so keep an air-tight joint.

Certain I am that the air-tighteners of boiler flues of brick-work come second in importance only to that of "vacuum" pipes about a steam engine condenser, concerning the great importance of painting or tarring, to which I have previously drawn attention. It is only lately that the porosity of brick-work, apart from actual cracks and mortar joints, has appeared to me so important as I now believe it to be. W. H. Booth.

London, Eng.




Micrometer Caliper.




*Pattern for Test Bar in Foundry Practice*

Test Bars.

### Improved Micrometer Caliper.

With this we present some improvements in micrometer caliper construction, recently introduced by L. S. Starrett, Athol, Mass.

The small knurled projection at the end of the spindle for revolving the screw rapidly, we have already explained, the present improvements consisting of an arrangement for keeping an even and smooth friction on the screw, and for locking it firmly in any position when desired.

The device for the first mentioned purpose is a close-fitting compensating nut, which is screwed into the outer end of the barrel, and constitutes a thimble, a shoulder on which comes solid against the end of the barrel. The inner end of this bushing is split, and a small section at each side sprung slightly inwards, and in a minute degree shortened in relation to the solid portion of the nut; and as the threaded ends of these sections bear upon the screw, they cause a smooth, uniform friction, and at the same time tend to draw the screw back, thus automatically taking up any lost motion which might result from wear. This obviates the necessity for splitting the barrel, and admits of more complete protection of the screw from dust and dirt.

The locking device is applied at the inner end of the barrel, and consists of thimble or nut screwed into place, and provided with a knurled collar or flange by which it can be screwed down onto a split bushing below, the end of this bushing being tapered, and the thimble fitted over it, so that when the latter is screwed in, the split bushing is closed firmly upon the spindle, locking it in position and making the caliper practically a solid gauge. The bushing can also be slightly closed when it is desired to make the fit of the spindle a little closer, either to compensate

for wear or for any other purpose. The outer end of the bow and the spindle are made of the same size, to admit of calipering close up to a shoulder or short projections. The cut is full size.

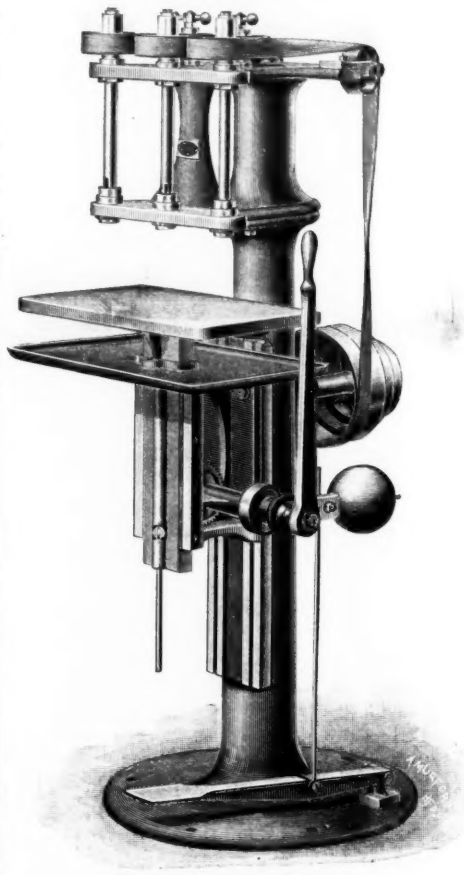
### Endless Belt Three-Spindle Drill.

The accompanying illustration is of a new endless belt three-spindle drill, recently brought out by The Dwight Slate Machine Co., Hartford, Conn., which is intended to meet the needs of manufacturers whose work is of such a character as to render it desirable to have a machine with a movable table, operated by the hand or by pressure of the foot, rather than their standard line of sensitive drills.

The arrangement of the table is similar to that formerly used on drills of this class, being adjustable vertically on the column, counterbalanced by the weight shown, and having a stop for gauging the depth of drilling, facing or counterboring.

The method of driving the spindles is new and original with Mr. Slate. A single endless belt passes up from the pulley below, over idlers and around the pulleys, which are on each spindle, other pulleys being placed in the rear of the spindles, which run on studs that are movable, to adjust the tension of the belt. In this way it is not only possible to keep the tension just right at all times, but the belt may be without a lacing, so that it runs much more smoothly than it otherwise would. The driving pulleys have their bearings on sleeves, which are supported rigidly in the frame of the machine, so that the pull of the belt in no way affects the spindles, either to pull them out of line or cause lateral wear. The belt used on the machine is 18 feet long, and it is in contact with from one-half to two-thirds of the circumference of the spindle pulleys, thus giving ample driving power with the minimum belt tension.

The capacity of the machine shown is for holes from 0 to $\frac{5}{8}$″ diameter. The spindles are of steel $1\frac{1}{8}$″ diameter, the holes in them being for the No. 2 Morse taper shank. They are $6\frac{1}{2}$″ apart from center to center, and will drill in the center of a 16″ circle. Greatest distance from top of table to spindle, 20″. Weight of machine, 650 pounds. The Slate Co. expect soon to bring out two other drills of the same general design, but having four and six spindles.



THREE-SPINDLE DRILL.

### Force, Motion and Work.

BY PEDRO.

THIRD PAPER.

ROTARY MOTION.

When a body moves in a curved path, which is endless, by "returning to itself," like that of a circle, or an ellipse, it is said to *rotate* or *revolve*.

When the path is a circle, then the indefinite line passing through its center, at right angles to the plane of the circle, is called the *axis* of the revolving body. The plane of the circle in which the body revolves is called the *plane of rotation*, or the *plane of revolution*.

*Rotation* and *revolution* are commonly used as synonymous terms, but some writers make a distinction between them. A body is said to *rotate* when its axis passes through its center of gravity, like that of a pulley, or a fly-wheel. A body *revolves*, when its axis is some distance from its center of gravity, like the balls of a common engine governor. The wheels under the end of a turn-table *rotate* on their own axle, and *revolve* about the center of the turn-table. It is the *rotation* of the earth which causes day and night, and its *revolution* about the sun produces the seasons. Rotary motion involves the

MEASUREMENT OF ANGLES.

Angles are measured in two ways; first, by the length of the arc included between the sides of the angle, and struck from the apex as a center, with a unit radius, as one inch, one foot, or whatever the unit of measure may be. Thus, in Fig. 3, let $D\ E$ and $C\ F$ be any two lines intersecting each other at $O$, and $A\ B\ D\ C$ a circle struck from $O$ as a center, with one inch radius. The part of the circumference of this circle which lies between the two lines, as $A\ B$ or $C\ D$, is a measure of the angle $A\ O\ B$ or $C\ O\ D$, so that by measuring this arc $A\ B$, we know the value of the angle. If $A\ B$ is one inch long, we would call it a *one-inch angle*. A $2\frac{1}{2}$″ angle has an arc $2\frac{1}{2}$″ long, etc. In the same manner the arc $A\ C$ is a measure of the angle $A\ O\ C$.

The arc $A\ B$, whose radius is unity, may, by analogy with specific weight, specific gravity, specific heat etc., be called the *specific arc*, to distinguish it from an arc, as $E\ F$, described with any other radius than unity.

The length of arcs included by the same, or equal angles, and having different radii, are proportional to their radii. Thus, in Fig. 3, arc $A\ B$ : arc $E\ F$ :: radius $O\ A$ : radius $O\ E$; hence $E\ F \times OA = A\ B \times O\ E$.

Now if $A\ B$ is the specific arc, then its radius $O\ A$ is unity, and we have

4 ..... $E\ F$ = specific arc $\times$ $O\ E$.

*Rule* 4. If the specific arc is known, we can find the length of any other arc by *multiplying the radius of that arc by the specific arc.*

Dividing both members of equation 4 by $O\ E$, we have

5..... .. $\text{specific arc} = \frac{E\ F}{O\ E}$

*Rule* 5. Given any arc and its radius enclosed by any angle, what is the specific arc which is the measure of the angle? *Divide the given arc by its radius*, the quotient will be the specific arc.

When the specific arc becomes a whole circle, its length is 2x3.1416 or $2\pi$, the number 3.1416* being represented by the Greek letter $\pi$ (pi), and it simply means that the circumference of a circle is 3.1416 times as long as twice its radius or its diameter.

The second method of measuring angles is by *degrees*. That is, the circle is divided into 360 equal parts, and one of these parts is called a *degree*, and is written thus: 2°, 10°, etc. (two degrees, ten degrees, etc.), and the number of such degrees included between the sides of an angle is the measure of the angle in degrees. Since the length of the specific circumference is $2\pi$,

$$\left.\begin{matrix}\text{specific arc}\\ \text{of 1 degree}\end{matrix}\right\} = \frac{2\pi}{360} = \frac{\pi}{180} = .01745+$$

Hence, to find the length of the specific arc of any angle, as $E\ O\ F$, Fig. 3, when it is given in degrees, we have the following:

*Rule* 6. *Multiply the number of degrees by* .01745, and the product will be the specific arc.

Again, having given the specific arc, to find the number of degrees in the angle, we have

*Rule* 7. *Divide the specific arc by* .01745, or, which is the same thing, *multiply by* 57.2956, the result will be the number of degrees in the angle.

The only difference between this and the first method is in the *unit of angular measure*. In the first case it is the linear unit, as one inch, one foot, etc., and in the second case it is the degree. In trigonometry, angles are generally measured in *degrees*, while in mechanics they are often measured by the *specific arc*. The following table is a comparison of the two methods by some of the angles most commonly used.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1st Method. | $\frac{1}{12}\pi$ = .2618 | $\frac{1}{6}\pi$ = .5236 | $\frac{1}{4}\pi$ = .7854 | $\frac{1}{3}\pi$ = 1.0472 | $\frac{5}{12}\pi$ = 1.3090 | $\frac{1}{2}\pi$ = 1.5708 | $1\pi$ = 3.1416 | $2\pi$ = 6.2832 |
| 2d Method. | 15° | 30° | 45° | 60° | 75° | 90° | 180° | 360° |

Having seen what rotary motion is in general, and how angles are measured, we are prepared to determine how to measure rotary motion. Here we meet with three kinds of velocities, viz., *circular velocity*, *angular velocity*, and *rotary velocity*. In Fig. 4, let $O$ be the center or axis about which a body revolves, as the balls of a governor or some point on a pulley, and suppose it to have moved from $A$ to $B$, in one minute, along the circular arc $A\ B$ with a uniform speed, then will the length of the arc $A\ B$ be its *circular velocity*†, and the motion, when uniform, is determined in the same way as in Rules 1, 2 and 3 (second paper) with this exception, that the *space* passed over is measured on the circular arc instead of a straight line.

Knowing the length of the arc $A\ B$ and its radius $O\ A$, we can find the angle $A\ O\ B$, passed through by the point $A$ in a unit of time, by Rule 5 or 7. This angle is the *angular velocity*, because it is the angle over which the radius $O\ A$ passes in the unit of time. This angle may be less or greater than $2\pi$ or 360°.

When the point $A$, Fig. 4, has passed around the entire circle, that is, when it has arrived at the point from which it started, it is said to have made one revolution or one turn. Hence, if we divide the angle $A\ O\ B$ or the angular velocity by the angle of *one turn* ($2\pi$ or 360°) we obtain the angular velocity expressed in a *fractional part of a turn* if the angle $O\ A\ B$ is less than $2\pi$, and in the *number of turns* if $A\ O\ B$ is greater than $2\pi$.

Thus, if the angular velocity of a body is $\frac{\pi}{4}$ then it makes $\frac{\pi}{4} \div 2\pi = \frac{1}{8}$ of a turn in one minute. If the angular velocity is $100\pi$ then it makes $100\pi \div 2\pi = 50$ turns or revolutions in one minute. This is the *rotary velocity*. Hence we have the expression,

*Rule* 8. Rotary velocity = $\frac{Ang.\ velocity}{2\pi}$

Or, if the angular velocity is expressed in degrees, then,

*Rule* 9. Rotary velocity = $\frac{Ang.\ velocity}{360}$

As there is no fixed unit of time in use, the expression "revolutions a minute" is generally used instead of "rotary velocity." For example, we speak of a pulley or a shaft as making 100 revolutions a minute. This leaves no doubt as to whether the 100 revolutions are made in one second, one minute or one hour, which might be the case if we should simply say that its *rotary velocity is* 100.

The *direction* of rotary motion is determined by a line which is tangent to the circle of rotation at the point where its direction is desired. For example, in Fig. 4, when the body is at $A$, the direction of its motion is in the line $A\ C$, which is tangent to the circle at $A$ or perpendicular to the radius $O\ A$. That is, if the body should cease to revolve at the point $A$, it would then, if perfectly free, move along the line $A\ C$, like a belt moving from a pulley, or a drop of water flying from a grindstone. In case of the belt, its linear velocity is the same as the circular velocity of the circle whose radius is equal to the radius of the pulley plus about $\frac{4}{10}$ of the thickness of the belt. The circular velocity of a wheel on any vehicle or railway car is the same as the velocity of the car itself. Hence if we know the velocity of the car, or belt, and the diameter of the wheel, we can find its rotary velocity, or number of revolutions a minute, by Rule 8. Or, if in Rule 8 we substitute for the angular velocity its equivalent in terms of circular velocity $v$, and radius of rotation $r$, from Rule 5, we have

10..... Rotary velocity = $\frac{v}{2\pi\ r}$

That is, having given the circular velocity, to find the rotary velocity:

*Rule* 10. *Divide the circular velocity by the circumference of the circle of rotation;* the quotient will be the desired result.

*Example.* A locomotive runs with a speed of 40 miles an hour or 3,520 feet a minute; the diameter of the driving-wheels is 5 feet; how many revolutions a minute do the wheels make? The circumference of a 5-foot wheel is 15.708 feet; hence by Rule 10 rotary velocity = $\frac{3{,}520}{15.708}$ = 224.+ revolutions a minute.

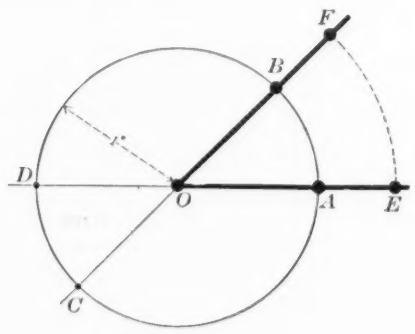



*Fig. 3*

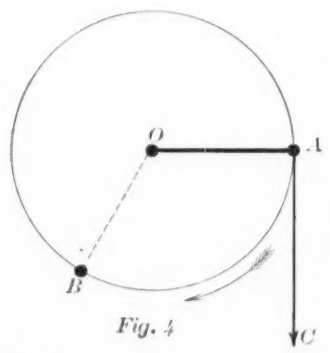



*Fig. 4*

FORCE, MOTION AND WORK.

* The following number has been given as being nearer to the true value of $\pi$, viz.,
3.14159265358979323846264338328O,
but the number given above is near enough for most practical purposes.

† Some writers call this the *linear velocity*, but we prefer "circular velocity," because it at once suggests the *kind of a line or path* in which the body moves.

The outcome of the land boom in Southern California has been to sink a good deal of the Eastern capital that has been invested there, and to leave the country in worse condition, so far as probable future progress is concerned, than before the boom. There is no occasion to pity the speculators who work up these booms in real estate; but they contrive to rope in a good many honest men, who have a little money to invest, and think they see their way to getting large returns. The genuine settlers are suffering severely from high taxes, the assessments having been made on the basis of an artificial value, about four times the real value to-day. It is the bona-fide settlers—men who have bought land to use, or have established business there—who are to be pitied. It is a good thing that the speculators lose by their operations. No doubt in time men will learn to let these land booms alone, and to let the towns alone in which they are being worked.

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NEW YORK, OCTOBER 10, 1889.

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## The Responsibility.

Railroad officials have found by experience that in the first few moments following a disastrous accident, the employes of the road are liable to make statements to newspaper men, and others, which make things somewhat awkward for the road when the official investigation takes place. The statements may be true enough, and, indeed, usually are essentially true, but they often cause facts to be brought to light which might not otherwise be proven. This has led to the closing of every employe's mouth the moment an accident occurs, making it very difficult to judge as to just what causes have led to an accident until the official investigation takes place, and no doubt adding considerably to the difficulty even then.

But, notwithstanding this, it seems at this time to be reasonably certain that the engineer of the forward section of the St. Louis express, which was wrecked on the New York Central road on the night of September 27th, made a mistake of judgment by continuing to run with a partially disabled engine, knowing that the moment he commenced to lose time the second section would, in all probability, commence to reduce the ten minutes headway upon which the safety of both trains depended. He should have either stopped at once and let a flagman go back, or kept on at the best rate possible after signaling for a brakeman to be dropped off the rear of the train while running to flag the second section. It seems probable that the occurrence of the accident to his engine, and the problems suddenly presented by it, caused him to forget the second section entirely—a thing which it is, of course, easy enough to say he should not have done under any circumstances, but which at the same time it must be conceded most any one would have been liable to do, and for which there is, therefore, some excuse at least.

The statement of the engineer of the second section, that the brakes refused to work, must, we think, be taken with a grain of salt. When there is anything wrong with the automatic brake, it is immediately applied to the wheels, the train stops and perforce remains stopped until the defect is remedied. The fact that automatic brakes are not applied to the wheels of a train is almost positive evidence that nothing is wrong with them, for they cannot be held off the wheels unless in working order. Therefore we say that it is altogether probable that if the engineer opened the brake-valve the brakes were applied. In the excitement which might naturally result from seeing the lights of a train too close ahead to prevent a collision, it is very possible that he failed to apply the brake, or, having applied it, thought it did not retard the motion of the train, and had failed to work.

The safety of railroad trains must always depend to a great extent upon the good judgment of the trainmen, and more particularly upon the judgment of the engineer; and, this being the case, it is likely that there will always be some liability of accidents, for no man's judgment is, or ever will be, infallible. Errors of judgment will always occur, and the best precaution which can be taken against them is to so arrange things that when they occur they shall be attended with the least possible danger to life.

We know of only one thing which would have certainly prevented this accident, and that is the block system of signals. If that system had been in use on the Central road the partial disabling of the engine, with the attendant error of judgment, would have delayed the trains, but they could not have come together. In view of the fact that the block system has been in use on the Pennsylvania road for some time, and is regularly employed in England, can the management of a road doing the amount of business done by the Central be held blameless when accidents occur, as a result principally of its failure to adopt an improvement so thoroughly proven to be an efficient preventive of such accidents? It is not to be forgotten that this road was the last one of any prominence to adopt the automatic brake, and finally adopted it only because practically forced to do so. Will it now refuse to adopt the life-saving block system until forced to adopt it? It is almost as certain as anything can be, that the lives of the persons killed in this wreck would have been saved had the block system been in use. It is equally certain that the road is, and has been for a long time, abundantly able to have that system. These being the facts, we cannot see how there can be much difficulty in fixing the moral responsibility for the accident and its consequences, however it may be with the legal responsibility.

A few years ago there was considerable argument in favor of largely increasing the weight of machine tools, but little seems to have come of this argument. It is safe to say that nine out of ten machine tools on the market to-day are lighter than they should be for the best economy, but builders will go on building light, weak tools, because they will sell. When it comes to putting fifty dollars more stock in a lathe, for example, the question of getting paid for the extra stock is, in these times of close competition, a very important one. When purchasers are willing to pay for heavy tools they will find builders willing to make them. But the demand must precede the supply. When it comes to getting hard work out of a machine tool, ten per cent. extra cost does not amount to much, but when it is a question of selling a tool that costs ten per cent. more than an another, it is uphill business. The manufacturers of machine tools must look at the commercial side of the matter, to the exclusion of other considerations.

A bright manufacturer of machine tools in England said, not long since, to the writer, "You in America are neither better nor worse than we are in regard to strength of machine tools, except that I believe that just now we are moving faster in the direction of greater strength than you are." We cannot quote him literally, further, but his argument was to the effect that metal is removed slowly, in machine processes, mainly from the fact that machine tools lack "backbone." And looking at the matter fairly, he was right. His idea—and it is good—was that such tools should be made two or three times as heavy as at present, and that by such construction it would often be possible to double the speed with which work could be machined.

A very pleasant custom has grown up in regard to the new naval vessels, which are named in honor of various cities of the Union, in accordance with which some valuable gift is presented to the vessel by the people of the city so honored.

Philadelphia proposed to give to the cruiser bearing her name a fine library, but it is now announced that this will probably be changed to a magnificent silver service, to be used, of course, by the officers exclusively. The reasons given for this are that the Government always furnishes a library suitable for the officers; that there is no room in the men's quarters for a library, and if placed in the officer's quarters naval propriety would make it inaccessible to the men. It strikes us that there is a degree of snobbishness revealed by this incident which is altogether out of place in this country. It has been borrowed from the Old World, and had better be returned at once. It is founded entirely upon the Old World notion—that some men are made of a quality of clay altogether superior to that of which other men are made, and that it is scarcely worth while to try to improve the inferior grade.

It seems to us that it would be a pretty good thing to try to attract to the service of our new navy a class of men who would appreciate books, and that room should be afforded in which to keep them, even if the amount of space devoted to the officers be curtailed somewhat. There is a good deal of nonsense about this naval propriety business, as well as regarding the matter of commissioned and non-commissioned officers in the army, which has been borrowed from the armies and navies of the Old World, and which is entirely at variance with the American idea that one man is as good as another, so long as he behaves himself as well.

The quicker we get rid of it, the better.

The Site Committee of the World's Fair has shown wisdom in concluding, in obedience to the expressed will of the people, to abandon the chimerical idea of erecting exhibition buildings in Central Park. Now, if they would abandon the idea they have of fencing off part of the Park grounds for refreshment booths and a recreation annex to the fair grounds, their exhibition of wisdom in respect to the use of Central Park would be complete. The people should not be fenced out of a single foot of ground for what is, after all, a business enterprise. A small surrender now will establish the precedent of unlimited surrenders hereafter.

## Literary Notes.

STEAM ENGINE DESIGN. For the use of Mechanical Engineers, Students, and Draftsmen. By Jay M. Whitham, Professor of Engineering, Arkansas Industrial University; Late Assistant-Engineer U. S. Navy.

Designers of steam engines will find this to be a very valuable work. It treats of the application of the principles of mechanics to the design of the parts of a steam engine of any type, or for any duty. The book is written in a clear, concise style; the rules for proportioning the different parts of the engine are given in the form of formulas, making the book, in this respect, a handy one for reference. The higher branches of mathematics are avoided as much as is consistent with the treatment of the subjects, so that the chapters on the valve and reversing gears; steam chest, links, eccentrics; compound and triple expansion engines; theoretical indicator diagrams of a compound engine; crank-effort diagrams illustrating the influence of the reciprocating and rotative parts of an engine; design of the piston rod, crosshead and guide; designs of connecting rods, crank-pin, crank-arms, crank, propeller shafts, bearings and couplings, condensers and pumps, propelling instruments, and the powering of vessels, can be understood by any one having a knowledge of the elements of mathematics, and obtain much information of a theoretical and practical character. The book contains 210 illustrations, which, on the whole, are excellent. The work is published by John Wiley & Sons, 15 Astor Place, New York. Price $6.00.

The *Northwestern Lumberman* has issued a special number, under date Sept. 28, giving a list of all the lumber operators in the States of California, Oregon and Washington, with complete details as to their lines of business and outfit. It also contains illustrated articles showing how lumbering is carried on in these States, and much special technical matter. The number is fully illustrated, has an artistic cover, and contains 140 pages of matter. Every one connected with lumber business will find matter of interest in this special number of the *Lumberman*. The price is 50 cents.

## QUESTIONS AND ANSWERS

*Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.*

*Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.*

(376) M. M. S., New Wilmington, Pa., writes: Please inform me where I can get a book treating on making patterns for skew-bevel gears. *A.*—Some of the underlying principles of forming skew-bevel gears are given in "Elementary Mechanism," by A. W. Stahl and A. T. Woods; also in "Kinematics," by C. W. MacCord. See AMERICAN MACHINIST of September 5 and October 10 for further information on this subject.

(377) C. H., ——, writes: Please state the correct method of catching threads in a lathe with a scale or rule. *A.*—Any method will answer by which the carriage can be run back an even number of inches while the lathe is standing still. One way of doing this is to simply lay the scale on the lathe bed so that the carriage will pass over it, stop the lathe when the edge of the carriage is in a

certain place, run back any number of inches, and close the nut again; or two chalk marks can be made on the bed of the lathe, and the position of the carriage gauged by them.

(378) C. H. A., Schenectady, N. Y., writes: I have read the article in your paper of July 4, in regard to glass triangles, and, as I have experienced the difficulties spoken of, I would like to try the glass triangles. Can you inform me where I can get the La Bastil glass spoken of by Mr. Booth? *A.*—After considerable inquiry here in New York, we are unable to say where the glass can be obtained; and dealers here say that it would be unsuitable for the purpose, for the reason that it cannot be cut.

(379) J. W. E., Chillicothe, O., writes: Will an upright boiler, with 6 square feet of grate area and 12 square feet of heating surface, supply an engine 2½x3 inches with steam at 60 pounds? Number of revolutions 300 per minute. *A.*—Yes; and much of the heat may also be wasted, because the grate area is too large for the heating surface. 2. What will be the correct proportions of the steam and exhaust ports? *A.*—About ⅛ of a square inch for each steam port, and about ¾ of a square inch for the exhaust port.

(380) "Reader," New Britain, Conn., asks: Will you please recommend to me a reliable work giving the capacity of lathes, planers, milling machines, etc., from which estimates can be made of the cost of sewing machines, steam engines and other mechanical work? *A.*—There is no work published which gives any information upon these points so far as we know, and we do not think, from the nature of the case, that a work of that kind, which would be reliable or be of much value, could be written. Estimates of the cost of such work must be made for each case by those familiar with such matters.

(381) E. L. L., Charleston, Ill., asks: Which is the most economical, a crank and fly-wheel pump or an injector, both to take water at 60 degrees and force it through a heater to boiler? *A.*—The injector used simply as a boiler feeder is more economical than a pump, because it heats the feed water; and the heat not expended as work in forcing the water into the boiler is returned to the boiler, with the feed water. Economy may or may not be promoted in using the injector in connection with a heater, because the heat given to the water in passing through the injector may be thrown away; in such cases the injector has a low efficiency.

(382) C. K., Philadelphia, Pa., writes: In your article on the Worthington high-duty pumping engines, you say (speaking of the compensating cylinders): "One of the advantages gained by the use of these compensating cylinders is that they are equally efficient at any speed, which cannot be said of the fly-wheel." Now, from what I can see, the function of these cylinders is to maintain a uniform piston speed. Am I right? Is not the object of the fly-wheel to store up the momentum of the reciprocating parts in order to assist the pistons over the dead centers, and not to make up for the loss of speed of the piston after cut-off? I was always under the impression that one of the objects of using steam expansively was to bring the piston to rest gradually. Now if the object of the fly-wheel is to produce uniform motion, then my impression is wrong, as, if the speed of the piston is uniform, I should think it would be liable to make an objectionable knocking at each end of the stroke. If you will just clear me up on this subject I shall feel much obliged. *A.*—The main object of a fly-wheel on a direct-acting pumping engine is to enable steam to be used with a greater degree of expansion than would otherwise be possible, or, in other words, to permit a shorter cut-off and lower terminal pressure than could be used without it. But with the fly-wheel and accompanying crank motion the piston speed would be gradually reduced towards the end of the stroke, even if steam were used at full pressure throughout the stroke. There is no necessity for a fly-wheel to help the piston of a direct-acting pump over the dead centers, because there are no dead centers in such a pump until the fly-wheel and crank are introduced. In an ordinary direct-acting pump the steam is usually cut off—not much, if any—before the completion of the stroke, and there is usually some compression of the exhaust. But the cut-off cannot be as early as it might be with a fly-wheel or its equivalent, for the reason that, if cut-off occurs too early, the steam pressure falls below that required to move the column of water, and, the moving parts having insufficient momentum to continue the stroke, the piston would come to rest before its completion. The fly-wheel, by storing up energy during the first portion of the stroke, and giving it out again towards its completion, enables steam to be used at the degree of expansion called for by considerations of economy. The size and weight of a fly-wheel are computed usually from the speed at which it is to run, the extreme variation of *rotative* speed allowable, and the range of steam pressures to be used from the initial to the terminal pressure. A change in any of these conditions would change the weight of the fly-wheel which should be used. And, as the speed of these pumps is not intended to be uniform, but to vary with the varying work to be done, the fly-wheel could not always be at its maximum efficiency. The efficiency of the compensating cylinders is more nearly uniform at different speeds. In using the words quoted by you from our article, we did not refer to variations of speed within the stroke, but to variations of the number of strokes within a unit of time.


## BUSINESS SPECIALS

*Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.*

Gear wheels and g-cutting. Grant, see adv., p. 16.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc., J. B. Roney, Lynn, Mass.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Prestoline & Prestoline Paste, for cleaning & polishing metals. S. A. Smith, 23 S. Canal st., Chicago.

Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Long & Short Hob Taps, Stove Bolt & Bit Brace Taps. M'f'd by S. W. Card & Co., Mansfield, Mass.

Iron Planers from 16″ to 36″ wide by any length. H. C. Pease & Co., Worcester, Mass.

Patent Attorney. R. G. DuBois, 715 11th st., Wash., D. C., procures first-class patents for inventors.

Curtis Pressure Regulators. Curtis Return Trap, Curtis Damper Regulator. See Sept. 12, p. 13. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N. Y. Send for des'n.

For the latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

The hook on steam engines is being supplanted by the Dill disconnecting device made by the T. C. Dill Machine Company, 726 Girard ave., Phila., Pa.

"Useful Hints on Steam." By E. E. Roberts. A book of over 80 pages; mailed on receipt of 20 cents. W. Blitz, 107 Liberty st., New York.

25″ 28″ 32″ 36″ Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E. Snyder, Worcester, Mass.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.

25″ 32″ 37″ 42″ "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

Eureka Cotton Machine Belting; a cheap and perfect substitute for leather or rubber belting. Address Eureka Fire Hose Company, 13 Barclay st., New York, for prices and samples.

Steam Boilers: Their management and working on land and sea. By Jas. Peattie. Practical facts from 30 years' experience. 230 pages illustrated, 12mo., cloth, $2. Circulars and Catalogue of Books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y

"*How to Work a Patent to Make it Pay*," by an experienced and successful inventor. Just published. 100 pages, cloth bound. Price $1.00. Send for Circular of Contents. J. F. Davison & Co., 120 Broadway, New York.

De Lamater Screw Propeller Wheel, made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and Equipment well adapted for Heavy Steamship Repairs.

H. B. Roelker, 22 Cortlandt st., New York, late Sup't Delamater Iron Works, will hereafter manufacture the Delamater Screw Propeller. Propellers of same pattern and workmanship as formerly made by the Delamater Iron Works. Each designed for its special work at lowest prices. Consulting Expert and Constructing Engineer. Estimates made on machinery and on damages.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

Patterson, Gottfried & Hunter (Lim.), 146–150 Centre st., N. Y., carry a complete stock of Brush, Copper, Celluvert Fibre, Oiled Paper, Hard Rubber, Rod & Sheet Brass, Brass, Copper & Iron Wire, Self-Hardening Tool Steel, Set & Cap Screws, Machine Bolts, Machine & Wood Screws, Taps & Dies, Files and Twist Drills, Blowers & Forges, Machinery, Tools & Hardware, Gear Wheels, Wood Pulleys, Shafting, Hangers & Belting. General factory supplies.

"Practical Drawing." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including October 10, 1889 issue, 87 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 101 articles have thus far appeared up to and including the October 3, 1889 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"How to Remove and Prevent Scale in Steam Boilers at a Cost of Ten Cents a Week," is the title of a neat little pamphlet mailed free on application to the Pittsburgh Boiler Scale Resolvent Co. The Pittsburgh Resolvent has been before the public for five years, and the demand for it is constantly growing. Parties who commenced using it five years ago are still buying it. It contains neither alkali nor acid. A recent letter from the superintendent of a water-works to the manufacturers says it not only keeps the boilers clean, but removed the scale that formed while using other compounds. The address of the Company is 405 Lewis Building, Pittsburgh, Pa.


## MANUFACTURES

Oscar Ruse is interested in a paper mill to be built at Carrollton, Ga.

It is said there are thirty shipyards in operation in the State of Maine.

The Chicago Bridge and Iron Co. is building a large plant at Chicago, Ill.

The Milburn Wagon Company, Toledo, Ohio, is erecting a building 80x365 feet.

The Rochester (Pa.) Pottery Works, recently destroyed by fire, will be rebuilt.

The Georgia Stove Company has been organized to manufacture stoves, at Atlanta, Ga.

The Kentucky Wagon Manufacturing Company will enlarge their works at Louisville, Ky.

Garth, Nash & Robinson's planing mill and cotton gin, at Bryan, Tex., was recently burned.

The Dunne Cutlery Company has been organized at Portland, Maine, with capital stock $50,000.

The Goldsboro Steam Furniture Manufacturing Company has been organized at Goldsboro, N. C.

The Cameron Iron and Coal Company are building a machine shop and foundry at Emporium, Pa.

The Athens (Ga.) Gas Company, in addition to adding an electric light plant, will enlarge their gas works.

The Crescent Roller Mill Company has been organized at Mammoth Springs, Ark., to build a flouring mill.

P. C. Holmes & Co., Gardiner, Maine, have their new foundry nearly completed. It will have a capacity of ten tons of castings per day.

The Abendroth & Root Manufacturing Co., New York, are building an additional shop, 175x200 feet, at Greenpoint. They have an order for eight boilers from Japan.

F. L. White's currying shop at Woburn, Mass., which has been idle for a number of years, has been leased by Mr. Quinn, of Peabody, who will manufacture morocco leather.

The National Screw and Tack Company will build a brick manufactory at the corner of Stanton and Judson streets, Cleveland, O. The building will be 40x120 feet, and four stories high.

The plans of the Anglo-Pacific Steel Co., to establish steel rolling mills at Vallejo, Cal., have been settled, and a site has been secured. The plant will cost $1,000,000, and 1,000 men will be employed.

Russell & Co., Massillon, Ohio, are building an addition to their works, 80x300 feet. The new building will have 60 feet clear height, making two stories at the side and one at the center. It will be equipped with a traveling crane traversing its entire length.

The Eclipse Wind Engine Co., Beloit, Wis., say the outlook for future business is remarkably good; so good that they will enlarge their shops for the fourth time in two years. Their rush of business is largely in friction pulleys and sheaves for rope transmission.

C. M. Lee is building a shoe shop at Athol, Mass. It will be two stories high, 22 feet wide and 110 feet long. It will be used for the manufacture of a new kind of children's shoes, known as "ooze calf.' Mr. Lee already owns three shops in Athol, and employs 500 hands.

The Industrial Association, of Easton, Pa., has undertaken to raise funds to erect a factory for making harness, horse collars, belting and the like, under the supervision of H. A. Sage, a practical manufacturer. The new factory is to start with sixty hands, with capacity for more.

The nail factories of Ironton, O., and Ashland, Ky., have under consideration the erection of a steel plant at the latter place, of 300 tons capacity per day. A grant of ten acres has been offered for a site. Three mills, with a total of over three hundred nail machines, are located at the two places.

The Richmond Street Motor Company has been incorporated at Richmond, Va., with Allen Talbott president, and William Simpkin vice-president and general manager, to manufacture motors for street railways. The capital stock is to be not less than $50,000 nor more than $1,000,000. For the present, motors will be made at the works of Simpkin & Hillyer.

The works of the Enterprise Hardware Company, Allegheny, Pa., owned by W. H. Burt and O. K. Gardner, were almost totally destroyed by fire recently. The company does a large business in the manufacture of novelties, such as door locks and keys, sash weights and light castings, and was rushed to its full capacity. The works will be rebuilt at once.

The Phœnix Electric Light and Power Company, for supplying electricity for light, heat and power purposes in the cities of New York, Brooklyn, and other places in the United States, has filed articles of incorporation in this State. The capital named is $500,000. The incorporators are George P. Valentine, C. W. Platt, E. L. Johnson and James B. Lathrop, of New York, and James W. Purdy, Jr., of Brooklyn.

There is water-works agitation at Manchester, Iowa; Fenton, Mich.; New Ulm, Mich.; Grand Rapids, Mich.; Bessemer, Ala.; El Paso, Tex.; Fenton, Mich.; Port Townsend, W. T.; Red Bluff, Cal.; Dallas City, Ill.; Greenville, Tex.; Murphysboro, Ill.; Shelbyville, Ill.; Carthage, N. Y.; Stockton, Cal.; Burlington, Wis.; Ithaca, Mich.; Valdosta, Ga.; Fullerton, Neb.; Troy, Ala.; Pictou, N. S.; Provincetown, Mass.; Bloomington, Ill.; Kingston, N.J.; Waukegan, Ill.; Wymore, Neb.; Ypsilanti, Mich.; Rutherfordton, N. C.

A Nashville (Tenn.) dispatch says: Prominent Tennessee and Alabama capitalists who have been in conference here, have just settled the preliminary details of a plan to consolidate all the big charcoal and steel furnaces in the two States under one company, and begin the manufacture of steel rails. The gentlemen interested left last evening for Alabama, to effect a temporary organization. Their plan embraces the consolidation of the La Grange, Ætna and Warner Furnace Companies, the Roan Iron Company, of Chattanooga, the Wayne County Iron Company and other proprietors.

The Plymouth Rolling Mill property in Conshohocken, Pa., was recently sold at sheriff's sale for $20,000, to Charles Hunsicker, attorney for Isaac Fegely and Jacob Fegely, of Pottstown. The place was sold on an execution on two mortgages aggregating $15,151.05. The Messrs. Fegely also have a claim of about $72,000 against the property, which makes its actual cost to them about $87,000. The plan includes a fully equipped rolling mill, brick office building and eight dwelling houses. A portion of the works was erected about four years ago, and the whole plant cost, it is said, about $150,000.

Mr. Arthur R. King, who formerly manufactured a line of specialties, including screw punches, tube expanders, ratchet drills, etc., is now well established in his new quarters, at Erie, 11th and 12th streets, JerseyCity. In addition to the business carried on in this city, he now has two foundry floors, each 100x50 feet, one of which is devoted to bench and other small work, while in the other, which is provided with an overhead traveling crane, the larger work, including loam moulding, is done. He is working a good many heavy castings for outside parties, such as beds for air compressors, sections of vacuum pans, etc. The Erie Railroad runs close by the foundry door.

T. F. Morrin, Jersey City, N. J., is doing a good business building the boiler illustrated in our issue of March 28. At present he is putting four in the electric light station on West 24th street and 13th avenue, New York. These are perhaps the largest boilers in the country, so far as heating surface is concerned. Each of these boilers is 30 feet high, and 13 feet outside diameter. The inner shell is of ¾-inch steel, welded, is 48 inches in diameter and 28 feet high. The heating surface of each boiler is 6,000 feet, and the grate surface 100 feet. The boilers are considered good for a pressure of 200 pounds, and are to be worked at 150 pounds. Mr. Morrin is also putting in other boilers having 5,000 feet heating surface, for electric lighting, and has just put in the second boiler after four years' day and night use of the first.

McKeesport, Pa., is to have a manufacturers' belt line railroad, which will not be over five miles in length, and is to cost a half million of dollars. The line is to be known as the Youghiogheny Connecting Railway Company, and its stockholders are prominent McKeesport and Duquesne manufacturers. R. G. Wood, general manager of the W. Dewees Wood Company, is president, and Charles H. Read, of this city, vice-president. The above, and James S. Kuhn, S. I. McFarran, of McKeesport, and A. B. Darragh, of Pittsburgh, compose the directory of the company. The route of the line is not made known as yet, but it is to connect with the plants of the National Tube Works Company, the W. Dewees Wood Company, the Monongahela Furnace Company, the Duquesne Plate Glass Works, the Duquesne Tube Works and the Duquesne Steel Works, besides other manufactories in and about McKeesport.—*American Manufacturer.*

The Philadelphia *Press* says: The Pennsylvania Railroad Company has just ordered the erection of a large car repair and machine shop at Wall's Station, on the Pittsburgh branch. The principal building at the new repair shops will be a circular building, subdivided into eight circles. The outer circumference will be about 432 feet, the second 236, and the third, or court, 100 feet. It will be built partly of brick, stone and iron, and the building will be well lighted. There will be tracks leading into doorways every few feet apart. Besides the car repair shops, a number of other shops will be erected, among which are a machine shop 91 feet 2 inches by 51 feet 2 inches; a blacksmith shop, 102 feet by 60 feet; an oil, glass and paint shop, 83 feet by 10½ feet by 20 feet; a lumber shed, 128 feet by 50 feet; a planing mill, 125 feet by 70 feet, and a boiler shop, 30 feet by 40 feet. These works will give employment to over 1,000 men, and those who live in the vicinity of Walls will get the preference. The work is to be completed by February.

## Machinists' Supplies and Iron.

NEW YORK, Oct. 5, 1889.

There is evidence of increased activity in iron, but it has not yet crystallized into material increase in price, although there is evidence of an intention to stiffen prices. The market still rules firm at quotations as below. Northern brands, No. 1 X Foundry, $17 to $18; No. 2, $16 to $17. Southern brands, No. 1, $16.75 to $17.25; No. 2, $16 to $16.50. Northern brands, Grey Forge, $15.25. Southern brands, $15.

## ✲WANTED✲

*"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.*

First-class machine pattern maker wants situation Address Pattern Maker, 2,315 Vine st., Phila., Pa.

Wanted—Position as mech. draftsman by a young man with practical exp. Address Box 30, AM. MACH.

Wanted - Position as mechanical draftsman by a young man; passed technical school in Norway. Wages $7. Address K. C., care AMERICAN MACHINIST.

Wanted—By a practical machinist and experienced foreman, a position as superintendent or foreman. Address J. L. A., AMERICAN MACHINIST.

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Wanted—To sell patent, or have manufactured on royalty at reasonable figures, Huyett's Drawing Board, illustrated in AMERICAN MACHINIST, Sept. 15, 1888. Address Mrs. D. D. Huyett, Waynesboro, Pa.

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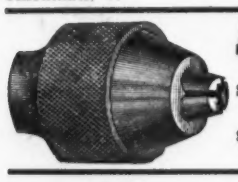

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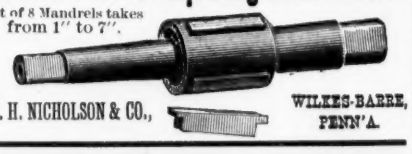
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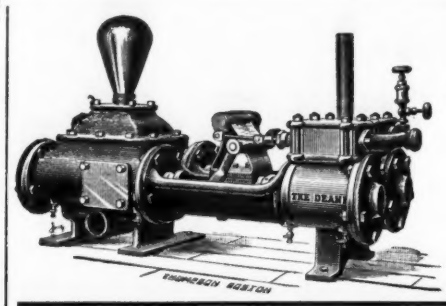


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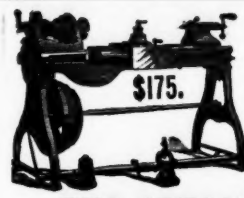


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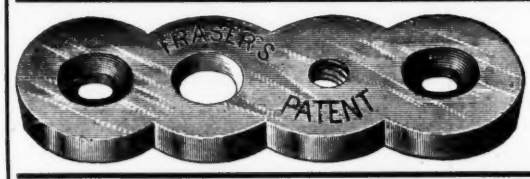


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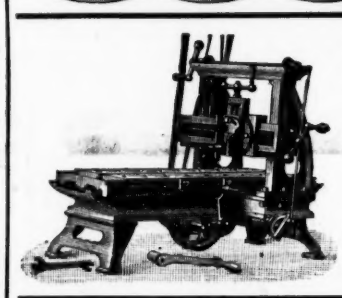

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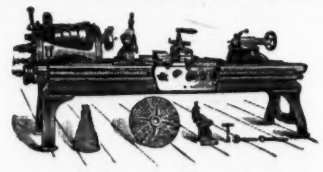
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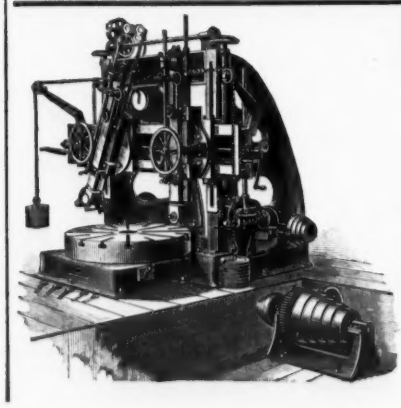
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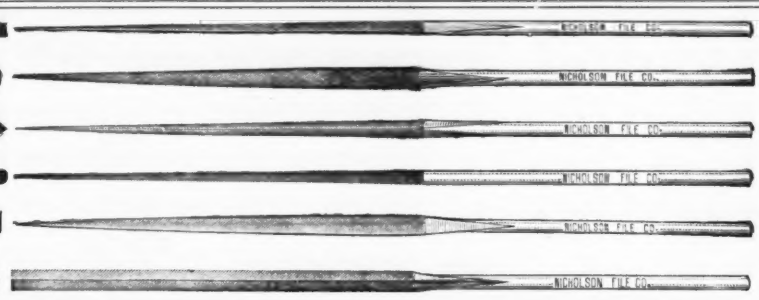


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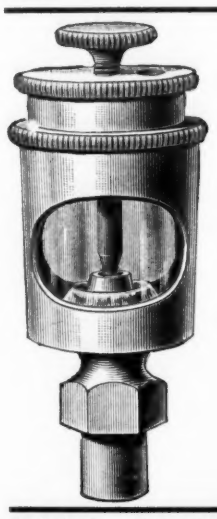

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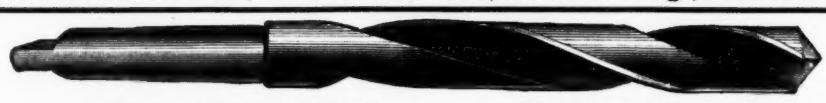

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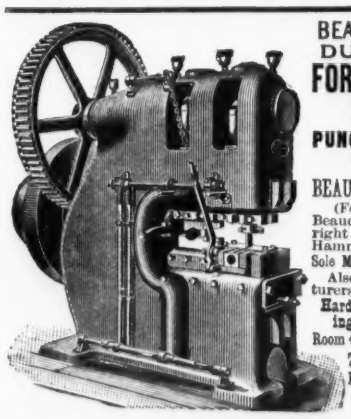

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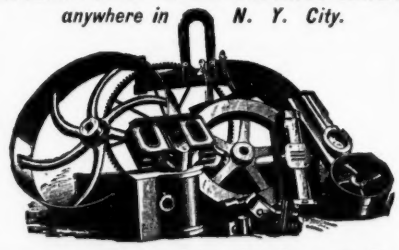

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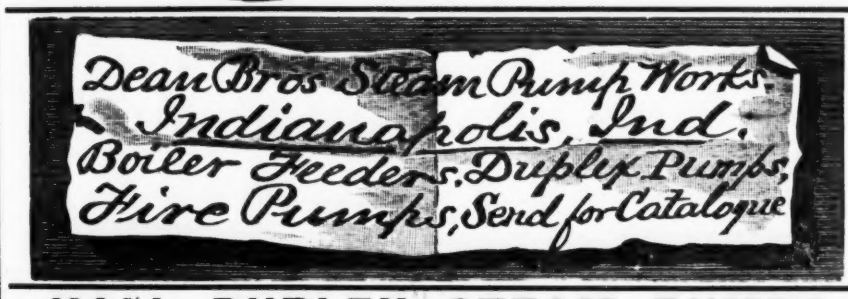


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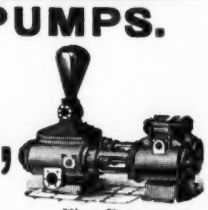

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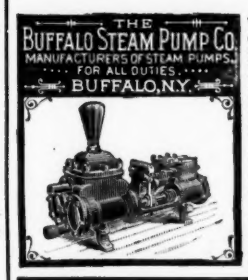


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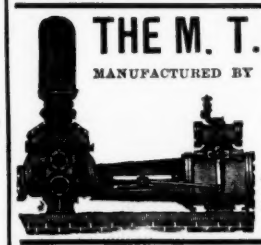

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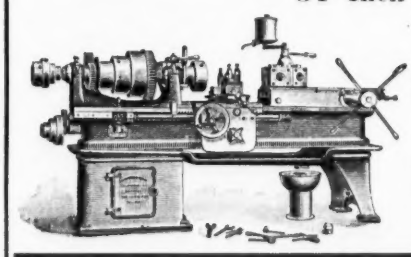

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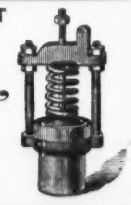

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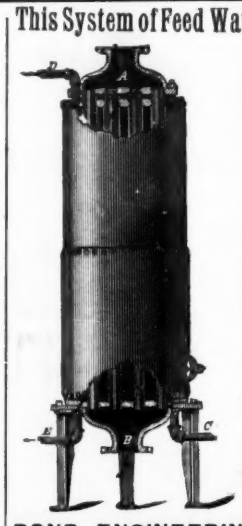

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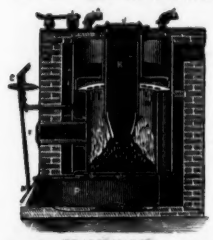

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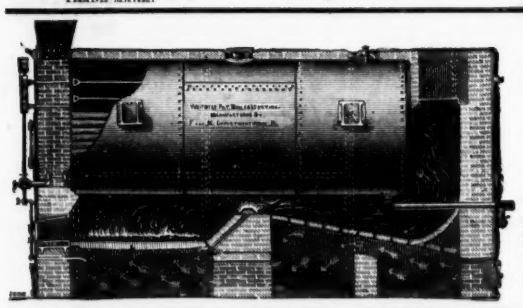

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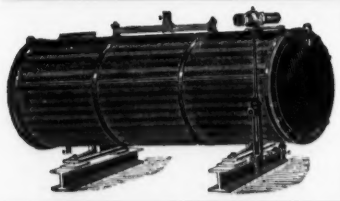

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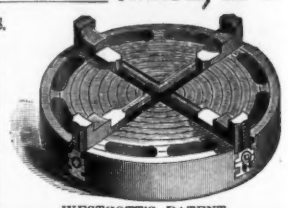

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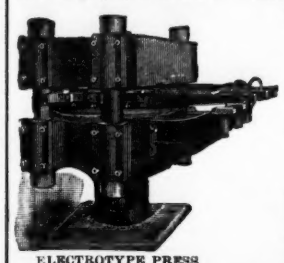

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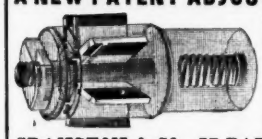

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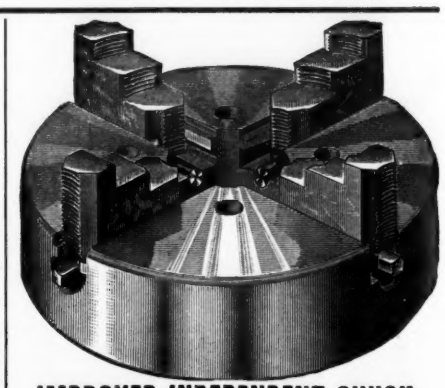

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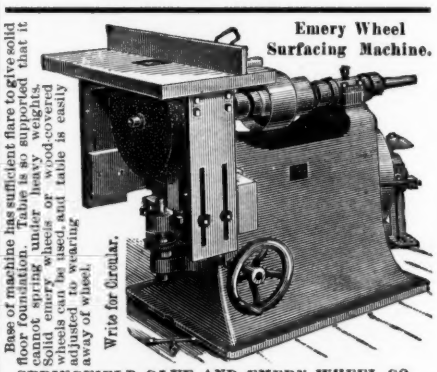

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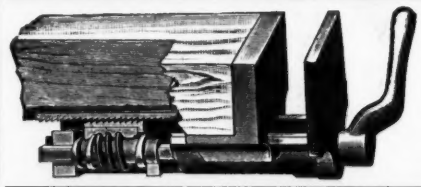

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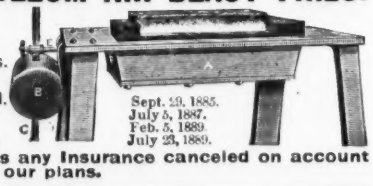


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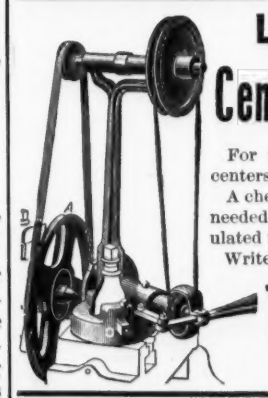

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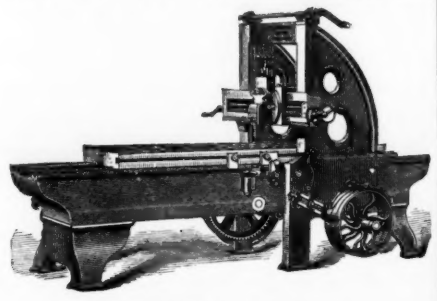

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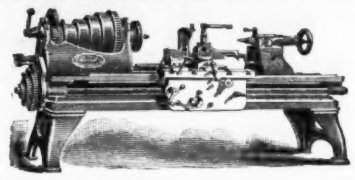

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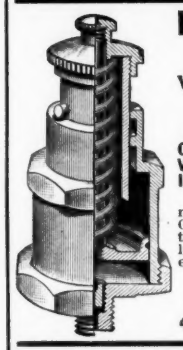

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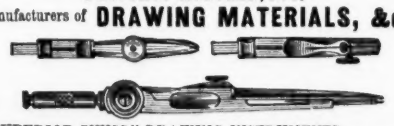

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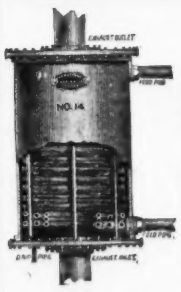

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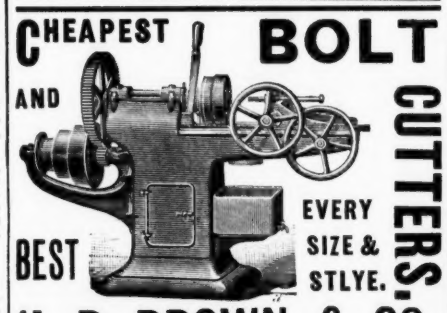

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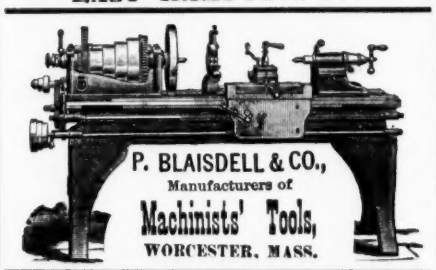

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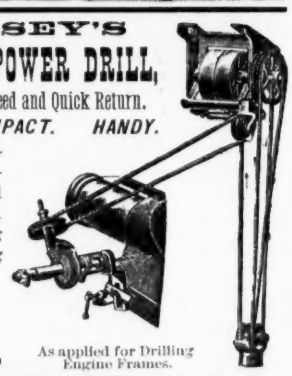

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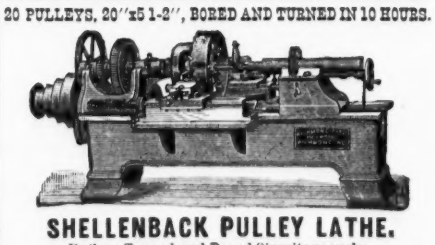

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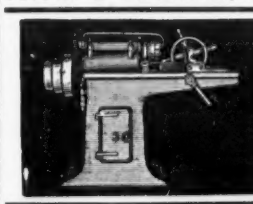

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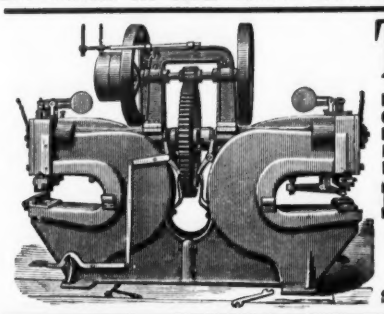

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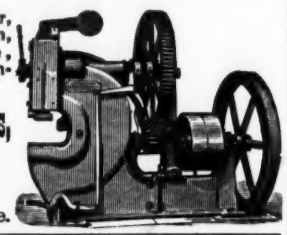

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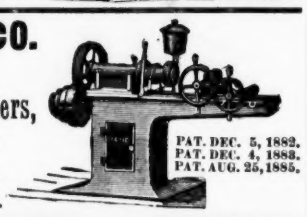

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PAT. DEC. 4, 1883.
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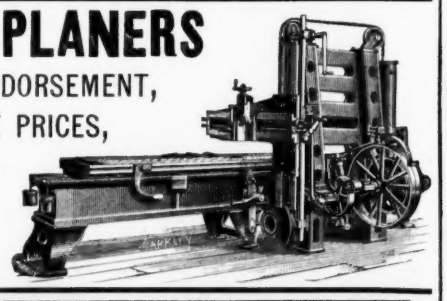

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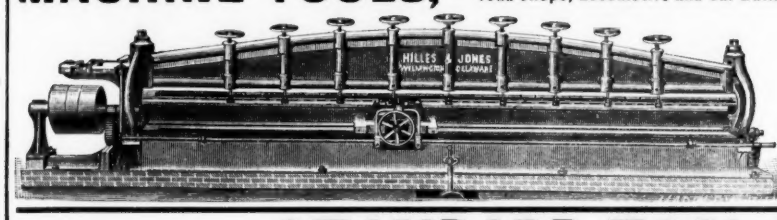

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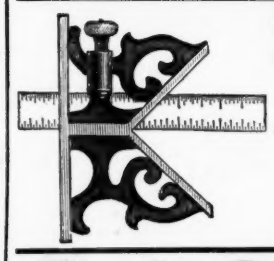

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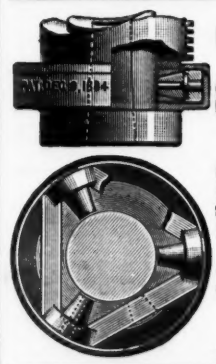

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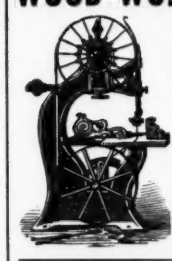

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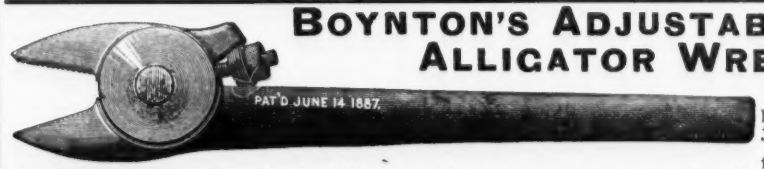


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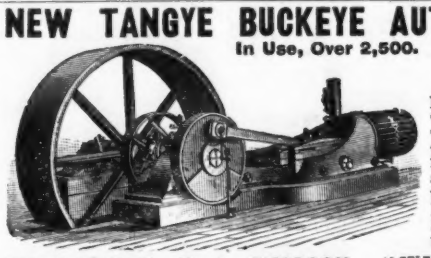

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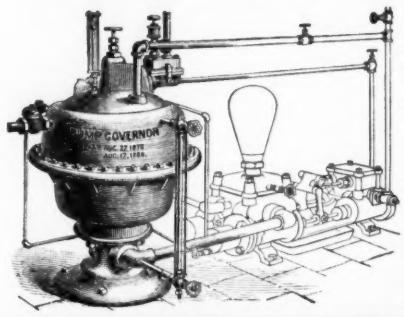

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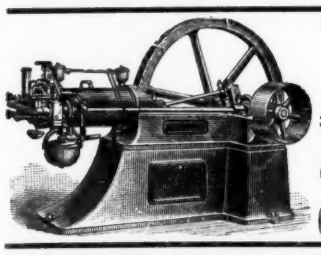

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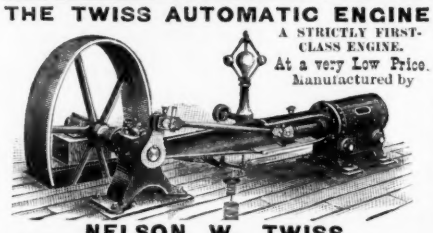

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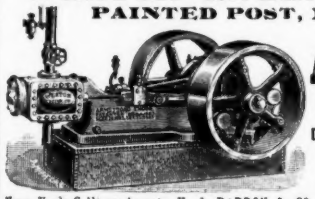

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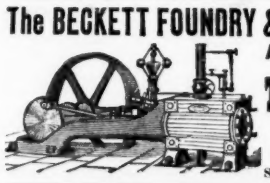

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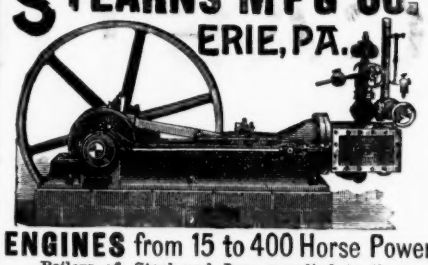

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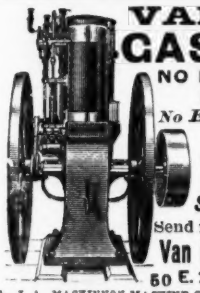

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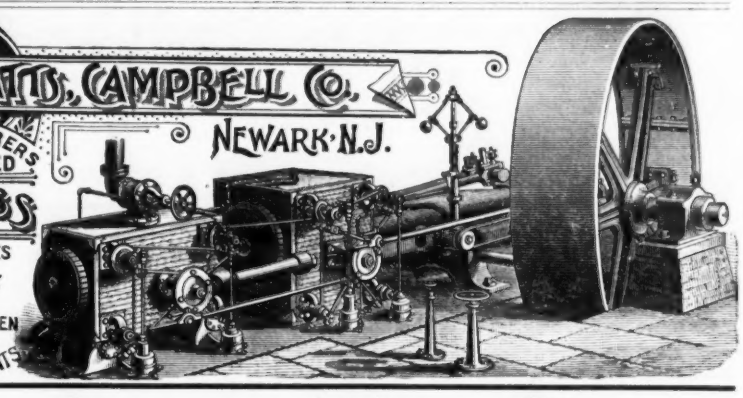

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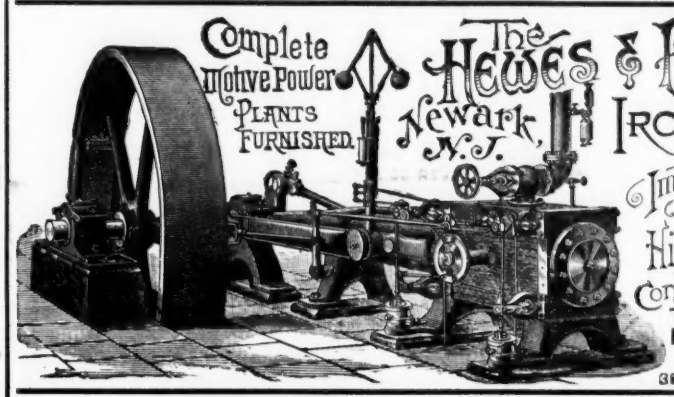

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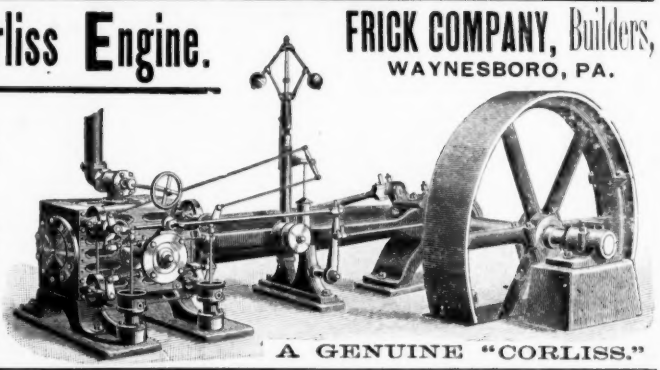

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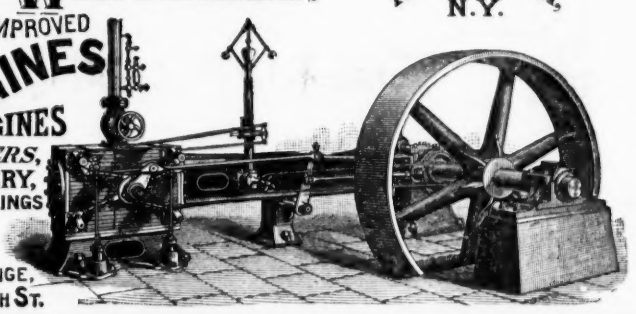

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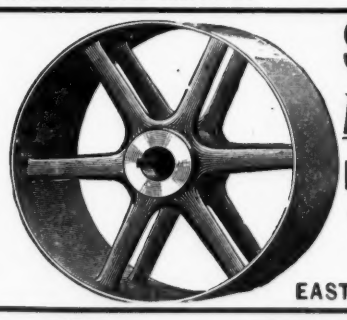

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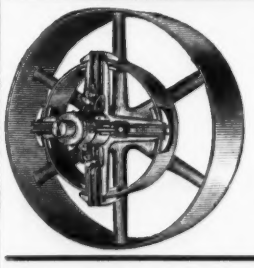

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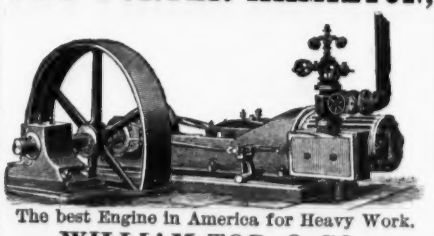

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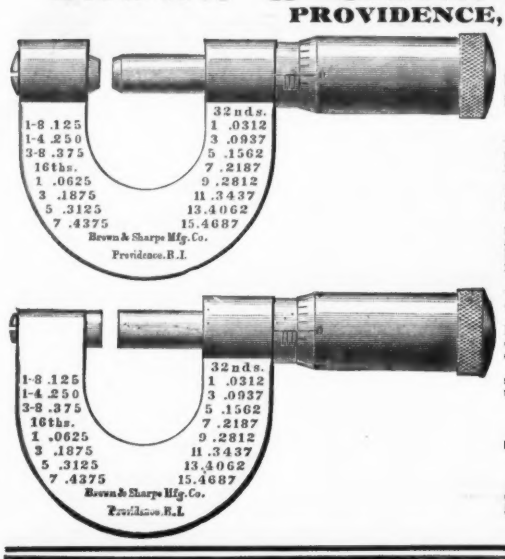


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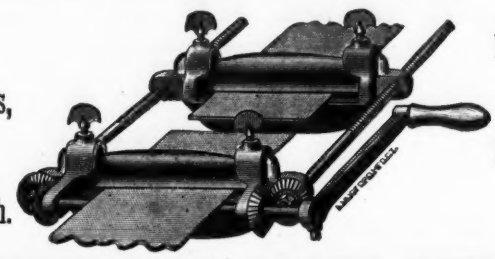

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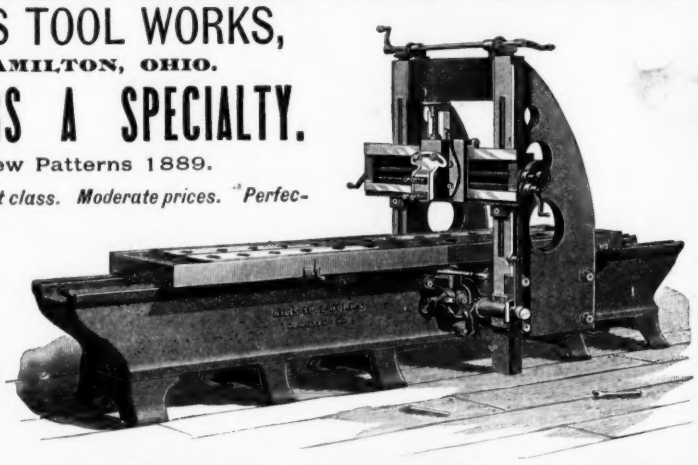

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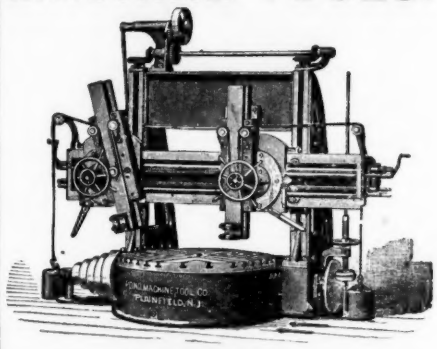

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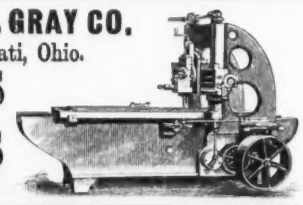

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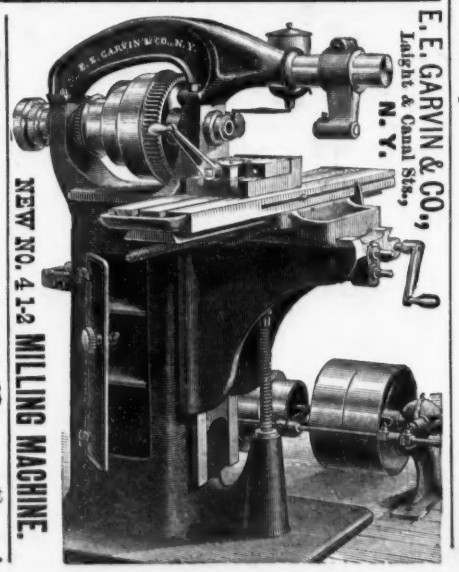

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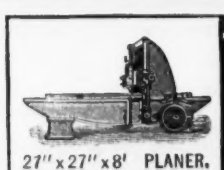


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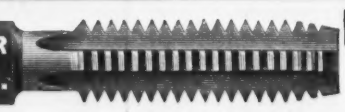

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